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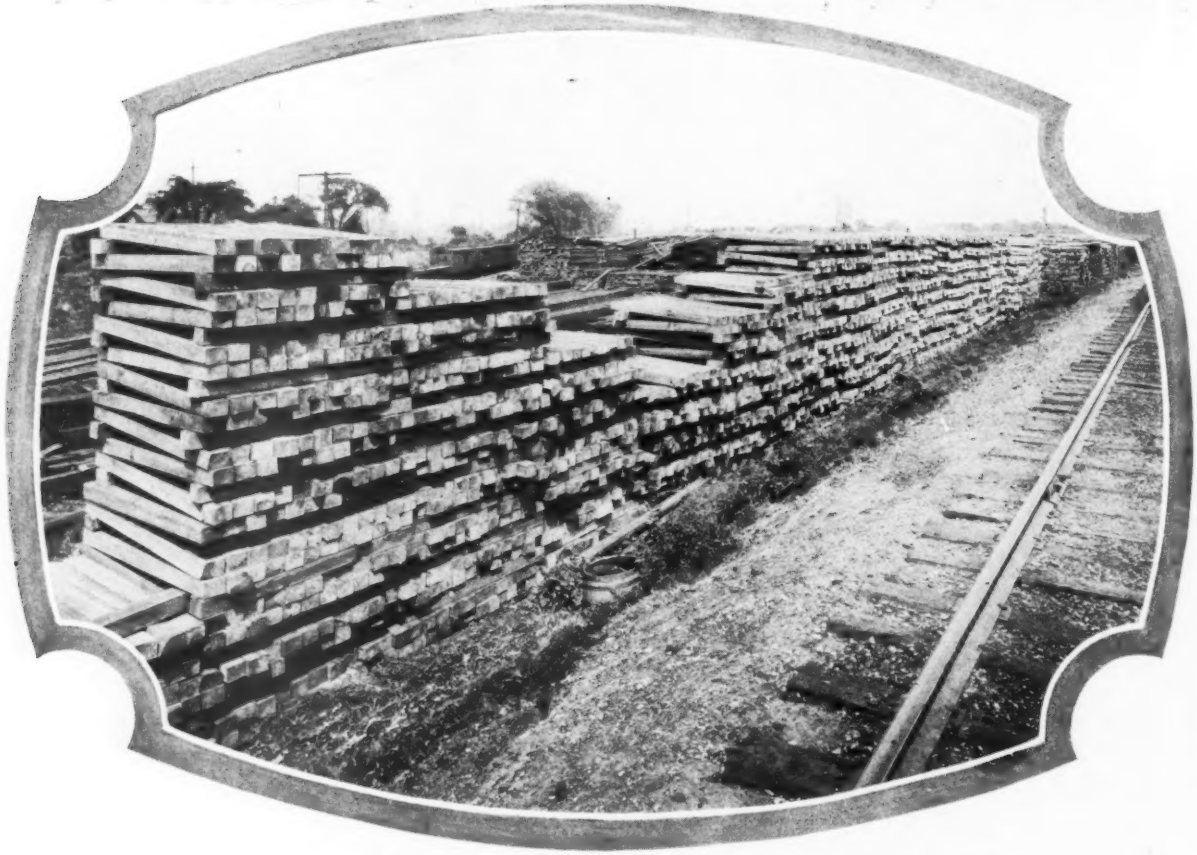
December 15, 1927

Engineering News-Record

Hand Mining
in Plastic Clay
on Detroit Water Tunnel

Tunneling Methods in Plastic Clay at Detroit
Composite Gravity and Hollow Type Dam on Pit River
Heat Changes During Setting of Alumina Cement
Ventilation Experiments in Moffat Tunnel
Reviews of Recent Books on Engineering Subjects
Chief of Engineers' Mississippi Flood Control Plan

KREOLITE



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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
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Worthy of Attention

SO FEW of our state utility regulating commissions have any control of municipally-owned utilities that much interest is aroused in any authoritative statement of how such control works where it does exist. In a recent paper before the American Bar Association, Lewis E. Gettle, chairman of the Wisconsin Railroad Commission—which has control of all the utilities of the state, regardless of kind or ownership—claimed great benefit for state control of municipal utilities. Chief among these, he stated, are putting plants on a sound financial basing through adequate accounting, prevention of unjust discrimination in rates to consumers, placing cost and other data on a comparable basis, as between plants in various localities, adjudication of rates where one municipal plant serves outlying municipalities and the giving of advice to the many small municipalities which would be lacking otherwise. These declarations are worthy of attention outside Wisconsin.

Reporting Highway Research

THE convention procedure of the Highway Research Board of the National Research Council deserves the attention of the highway industry. Interest in highway research has been developed. At the meeting of the board two weeks ago in Washington there was a large attendance; the talent represented was notable. Success in carrying to this audience the fruits of highway research was not at all notable. With its considerable numbers and its great aggregation of talent the audience in convention at Washington two weeks ago gained less from the meeting than it had a right to expect. Very few of the committee reports were presented in such form that more than fragmentary understanding was possible. Brief and largely aimless discussion, except in a few notable instances, was the result. This is not a criticism of the reports. Whatever of good they contained was not driven home to the audience; their presentation left their contents and their significance indefinite and uncertain. In extenuation it has to be admitted that surveys and studies involving many factors and a multitude of figures are not easy to epitomize orally so as to ensure true valuation. The task may be accomplished, however, for in instances at the Washington meeting it was accomplished. It requires time and study and as the committee work of the Highway Research Board is conducted the parts of the reports in the hands of different members of the committees are not assembled until almost the day of their presentation and there is no time for careful coördination and adequate analysis and summary. The result is a handicap no less on the chairman who presents the report than on the audience which listens to its presentation. There is a radical change required in the procedure of coördinating and presenting committee work at the annual meetings of the Highway Research Board or it had better be left for presentation only in the printed proceedings and the time of the meeting be devoted to papers on special research problems and on the functions and procedure of research.

Standardized Tunneling

A TUNNELING practice peculiar to itself has been developed by the city of Detroit in its public works for sewerage and water supply. A plastic clay extending to great depth underlies virtually the whole widely extended city. In this clay literally dozens of miles of sewers and water conduits have been built in tunnel to meet the crowding requirements of a city growing in a decade to metropolitan dimensions exceeded by those of only three cities in America. Out of this extensive experience has crystallized a tunneling practice which is almost as fixed as the full-width heading and bench method of solid rock tunneling which American railway engineers have developed. This practice is epitomized in this issue by the description of the new water supply tunnels which will add 900 m.g.d. to Detroit's supply of potable water. Outstanding in this practice is the use of tunnel boring machines. Nowhere else in the United States have machines for boring full diameter tunnels reached such common use. But hand tunneling procedure is nearly as distinctive in its use of power draw-knives. Whether machine boring or hand driving are employed the procedures are almost standardized for each. This is as true of timbering as of mining, and of concrete or brick lining as of excavation and timbering. Indeed with tunnel work to be undertaken in Detroit by local engineers and contractors, one can predict with very considerable certainty the limits within which there will be any variation in methods by which any of the operations will be conducted whoever the constructors may be. The change is rather remarkable since a few years ago when both the local tunnel contractors and those coming in from other cities were experimenting with many devices and methods.

A Bad Plan Abandoned

ABANDONMENT by its author of the form of board to administer the "unification" of rapid transit in New York City proposed by Samuel Untermyer, special counsel to the Transit Commission, is announced. The heterogeneous composition of the board proposed by Mr. Untermyer, the scattering of responsibility for selection of the members and the other undesirable features of the plan were presented at length in these columns for Oct. 3, 1927, p. 579. In the change in plan, the main fact of general interest is that the adminis-

trative board would be appointed wholly by either the mayor or the Board of Estimate, and thus be responsible to the city government and the citizens and taxpayers whom they represent.

The Mississippi—A Future Problem

LITTLE noticed by the public press, General Jadwin's report on the great national problem of controlling the Mississippi River was laid before Congress a few days ago. Its lack of popular appeal may be due to its cold phrasing and the failure to cover preliminary facts and data; one might almost think that the able Chief of Engineers believed the subject to concern himself and Congress alone, so little does he dramatize it in his report. But whatever its shortcomings the report is a great document. It marks an epoch in the history of the river.

First of all it is brilliantly courageous. Unhesitatingly it declares the past policy of sole dependence on levees a failure in the light of present facts; and just as unhesitatingly it accepts and endorses the existing levees as the logical and necessary mainstay of future protection. It does not temporize with the various panaceas and special schemes that have been advocated during recent months as solutions of the problem. To supplement the levees, four bypass channels for the top of the flood are outlined as essentials, while reforestation and reservoirs are declared to be incapable of meeting the needs of the case. All these matters, as they are set forth in the report, present themselves as simple conclusions of sane common sense, and this is the second great point of excellence. The sane and simple engineering of the report constitutes its strength, and offsets its heterogeneous arrangement and other defects. Gen. Jadwin and his co-workers have made a lasting contribution to man's knowledge of an age-old phenomenon of Nature. They are entitled to warm appreciation of their achievement.

The report has serious omissions; indeed it is as notable for what it omits as for what it says. The two overshadowing questions raised by last summer's flood are not mentioned, namely whether it is possible to foretell how great a flood may occur, and whether the existing levee type can be made to hold or must give way to something better.

In the matter of prediction of greatest flood, one is bound to note that the best judgment of the past has time and again proved at fault, and to ask whether the present prediction is any more certain. Can we with reasonable assurance proceed to plan protection against the greatest flood of the future? To such questions the report gives no answer; even the importance of the questions is not suggested. Since the capacities of the several channels are not stated, no basis is given for judging how fully they will serve in an extremity. The reader will conclude that the recommended project looks good; that it may be good; but that it will want more study for verification.

And as to levee type, one will ask whether the failure of the levees at more than two hundred points last spring throws doubt on the efficiency of the type. Is the conventional method of building in need of improvement? Even under Gen. Jadwin's plan the levees must continue to hold the highest flood stages so far recorded, since the bypasses come into action only at higher stages. Will they hold, or may another 1927 disaster come to pass? It is useless to provide floodways for a speculative maximum flood if the levees will fail before the water has passed the 1927 stage. So the thousands of miles of levee line must be made impregnable. We hope it can be done, but we are given no assurance that it can. The report recommends increase of levee section; it does not attempt to show that this strengthening will assure safety, or that it does so with due economy. Here again the arbitrary recommendation looks good; it may be good; but verification is much to be wished for.

The preceding is said somewhat apologetically. So great a task, and such driving haste as must have been necessary to perform it in six months' time, make it humanly impossible to render a complete report and answer all questions involved. But for this same reason the project recommended can not be taken as a finality. True, it is laid down in specific terms, as though it were final; but since not even a topographical map of the flood area exists, any claim of finality of design would be tenuous.

In short, the report is to be regarded as a preliminary outline of the course along which the working out of the ultimate solution is to be sought. To look upon it as anything more would be to misapprehend the intricacy and size of the problem, and would fetter the further development of thought concerning the solution.

In recommending that a complete topographic map of the river basins be made, and that special questions of the river be studied in a national hydraulic laboratory, Gen. Jadwin concedes the preliminary nature of the project. The need of a map is primary. As to a laboratory, the multitude of local problems and points of trouble along the Mississippi, each with potential bearing on flood conditions far beyond its immediate neighborhood, is warrant enough for expecting much help from such an institution. On the surface, for example, it is not obvious that river straightening or shortening by cutting off narrow necks—bends which have developed nearly to the point of spontaneous cutting—can be disposed of summarily. Perhaps laboratory work would help; perhaps a fifty-thousand-dollar study in the laboratory could show how to avoid a waste of five millions in the field.

There is also the difficult subject of channel stabilization. The present small amount of revetment is to be increased on a great scale. Very possibly, additional stabilization works will have to be adopted. Holding the banks is, in fact, one of the great unsolved questions of the river. A modest $110,000,000 is to be spent on this work within the next ten years. Granting that only full-scale experience can show precisely how to apply this money effectively, it is nevertheless likely that model experiments may serve as useful guides to limit the range of full-size trials and to direct them along lines of probable success.

Not only the general aspects but also certain individual items of the engineering project draw attention. The proposed Bonnet Carré spillway, for example—a controlled outlet capable of passing or stopping a flow of a quarter million second-feet—is a sluiceway of dimensions so great that its details, when developed, will be of unusual interest. The proposed control of inflow to the three great flood bypasses on the west bank, by levees which are to be allowed to scour out by over-

topping and thus admit the diversion flow through a crevasse, equally invites study. As the report does not discuss other methods of controlling the diversion, it is to be assumed that none other than this rough-and-ready one was believed feasible. There is also the special case of the New Madrid riverbank bypass, which is expected to fill by the overtopping of its east levee. Will the presence of this levee (or its remains) prevent the bypass from reaching its full flow-carrying effect? If so, Cairo may be in jeopardy. The report does not clear up this point. Nor does it answer the often-discussed question whether the Atchafalaya, if it takes a flow large enough to relieve the lower Mississippi effectively, may appropriate the entire flow and form the new outlet of the river.

There must be certainty on all these matters before the project is definite. To attain it will need years of study, and such study should begin at once. But also the actual construction must soon be started. Inevitably the study, design and construction will proceed hand in hand, from the first beginning to final completion of the work.

Thus the case calls for immediate decision on the method of organization through which the work is to be performed. The very best type of organization will be needed, one that will endure to carry the work to its end. A huge expenditure and great human anxieties are at stake. Nearly three hundred millions are to be spent—perhaps in the end much more. Various states are expected not only to contribute money but also to co-operate by legislative and administrative measures. The situation is novel and difficult.

How shall it be met? Is the Mississippi River Commission in some modified form of organization the proper instrument? Shall the interested states have representation? Is a normal engineering organization of the type which built the Catskill Aqueduct or the Miami Conservancy work the right one? Is the dictatorship type of the Panama Canal the one to follow? These are interesting questions for Congress, or for the President.

A plan of action is recommended in the report: Put the work under the direction of the Chief of Engineers; make it like the present river and harbor work, and transform the commission into an advisory body having nothing to do except when its advice is asked. Just how an already overworked Washington official is to add a three-hundred-million planning and construction task of extreme difficulty and complexity to his present duties and assure its sound conduct is not explained, and we think is not likely to be explained. The proposal impresses us as unfortunate.

A reason is given for the suggestion, namely that divided responsibility is harmful (under the present law the Chief of Engineers has veto power but not initiatory power over the commission). The distinction is fine-drawn, for at least in civil life any true veto power carries a guiding responsibility. If hitherto the Chief of Engineers did not co-operate and guide, it may not have been wholly the fault of the commission. But if for any reason the present arrangement has not worked well, the divided responsibility can be done away with by abolishing the Chief of Engineer's veto and making the commission independent. It would then be a vital organization, to stand or fall on its merits. Gen. Jadwin does not mention this as even a possible course, but he does propose the opposite plan, a plan which would leave the commission with the mere appearance of responsibility.

We trust this proposed method of directing the work of Mississippi River control will fail of adoption, and we rest our case on four reasons: *First*, an undertaking so great and so difficult as this is not one to be carried on as part of the routine of a Washington bureau. *Second*, the Corps of Engineers, with its emphasis on rank rather than experience in a particular field of endeavor, with its frequent change of service, does not provide the type of organization that will prove most effective. *Third*, the loyal co-operation of the thousands of workers can better be stimulated in an organization in which army rank is not the prerequisite of responsible authority. And *fourth*, men outside of the Corps of Engineers, of technical ability such as the undertaking demands, will not be attracted to the work except on the basis of equal responsibility and authority with the army engineers.

Tunnel Ventilation

WITH the decision to operate the six-mile Moffat tunnel by steam locomotives, the engineers were faced with the problem of providing adequate ventilation for safety and comfort by removing the smoke and gases from this long bore—even from a train stalled or halted in the tunnel. In the study of this problem special investigations and experiments were conducted, the methods and conclusions of which are noted elsewhere in this issue. With steam operation in railroad tunnels of even moderate length there are elements of discomfort and danger resulting from the smoke and gases and the difficulty of removing these products of combustion from the tunnel. In the cars, the effect usually does not go beyond nuisance or discomfort, but in the engine cab the gas, smoke and great heat may overpower and even kill the engine driver, thus imperiling the lives of passengers.

Ventilation methods as applied to railway tunnels consist generally of blowing in or exhausting sufficient air to create a current traveling faster than the train and so carrying off the products of combustion ahead of the engine. This method has been applied also in certain highway tunnels. But in the more elaborate system adopted for the new highway tunnels under the Hudson River at New York (*Engineering News-Record* of June 9, 1927, p. 934), an exhaust ventilating duct is formed in the roof by means of a partition or ceiling, with openings into the tunnel through which smoke and fumes are withdrawn. So far as known, no such system has been applied to ordinary railway tunnels. Its introduction would involve an enlarged tunnel section, at considerable cost. Whether it would be practicable to handle the great volume of smoke and products from locomotives in this way is a problem for the solution of which little information is available.

Since the number of large tunnels is increasing, it is fortunate that the general problem of ventilating long railway tunnels is being greatly simplified by the introduction of electric traction, either for the tunnel alone or for the entire operating division on which the tunnel is situated. The steam-operated six-mile Moffat Tunnel thus becomes a rather isolated case, hardly likely to be duplicated. Nevertheless it is a highly important case, and the design of its ventilating plant and results of operation will not only be watched with interest but will also furnish information of value in relation to the general subject of tunnel and mine ventilation.

Tunneling Methods in Plastic Clay at Detroit

Tests of Half-Diameter Concrete and Brick Rings Determine Lining Design for Ten-Mile Tunnel—Contract Conditions, Construction Methods and Plant

NEARLY ten continuous miles of undercity tunneling are in progress for the additional water supply of Detroit, Mich. The engineering control and construction planning of this work have been particularly careful and the equipment and methods employed exemplify the practices which have grown out of ten years' experience in tunneling the varieties of clay, with interspersed sand pockets, which underlie most of the city area. Tunneling in free air and under light pressures and tunneling by hand methods and by machine boring, with various styles of timbering, are represented. The tunnels are at greater depths, 60 to 100 ft., than have previously been recorded in Detroit. This article is limited to the features indicated of the work actually under way.

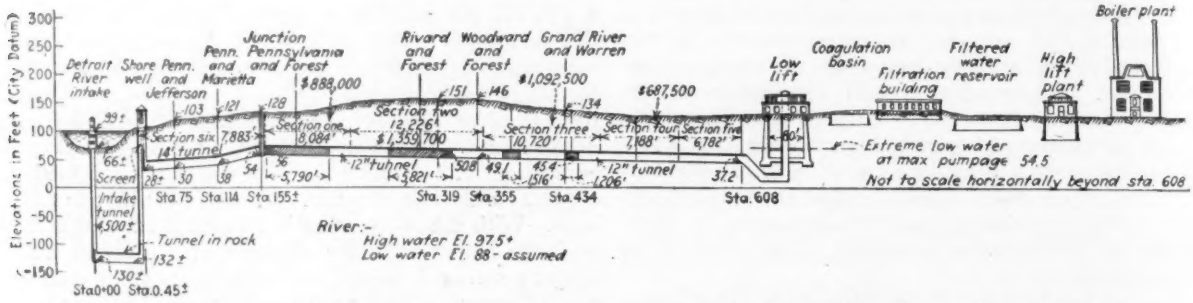


FIG. 1—DIAGRAM PROFILE OF SPRINGWELLS LAND TUNNEL, DETROIT ADDITIONAL WATER SUPPLY

Part of Large Project—The new ten-mile tunnel is part of an aqueduct system which includes for immediate construction a 4,500-ft. intake tunnel under the Detroit River and for future construction a second undercity tunnel of as yet undetermined length. Ultimately each of the land tunnels will have, at its inland end, filtration works and pumping stations. The plans for these accessory works have not reached a stage where they can be talked about. Also the location of the intake and of the intake tunnel is not finally determined. The construction definitely in progress, then, is the first land tunnel running generally westward across the city from the present pumping stations and filter plant on the shore of the Detroit River. Its structures are indicated by the profile Fig. 1. When the whole tunnel system and its accessories are completed, they will furnish to Detroit an additional water supply of 900 m.g.d.

Engineering Organization—An engineering setup independent of the regular Detroit water department engineering organization was created to plan and direct the work for additional water supply—intake and land tunnels, filtration works and pumping stations. This organization, developed in detail only for the bureau of land tunnels, is indicated by Fig. 3. For the assistant-engineer heads of bureaus and down through the grades of employees including instrumentmen, the city civil service commission suspended the residence rule and opened the examination to engineers throughout the country. It held examinations in 22 cities. It also called on the University of Michigan to prepare examination papers for the various positions; a committee of three professors in the engineering school did this and afterwards graded the papers. Then applicants with passing grades were given oral examination by a committee of water department heads, professors from the university and the secretary of the civil service commission. From the final eligible lists selections were made for all positions listed.

General Engineering Design—The lengths of the several sections of the first land tunnel are indicated on Fig. 1. From the present water-works a 14-ft. tunnel runs north to Forest Ave. Its calculated capacity is 530 m.g.d. At Forest Ave. a junction chamber will be constructed. From this a 12-ft. tunnel will run west under Forest, Grand River and Warren avenues to the new Springwells pumping station. The capacity of this tunnel is 327 m.g. daily. When at some time in the future the second land tunnel is built it will run generally north from the junction chamber to a proposed northeast pumping station and will have a capacity of 203 m.g. daily. The sizes were computed on the basis of the head available and $C = 120$ in the Hazen-Williams formula. In general the route was laid out to avoid large buildings and to penetrate the best soils for tunneling.

To determine soil conditions two sets of borings were made. These disclosed, at the tunnel grade, blue clay of varying consistencies but on the whole of a character quite favorable for tunneling. In this clay at intervals there were sand pockets. Generally these were more frequent east of Woodward Ave. than west; also the clay east of Woodward Ave. was in general softer than that to the west. As a rule the borings showed a fairly stiff clay at the surface, then an increasingly softer clay down to 30 to 50 ft., and then gradually stiffening material as the depth increased.

These soil conditions had consideration in developing the tunnel profile. It was necessary, however, regardless of all else, to keep the top of the tunnel at or below hydraulic gradient for any condition of river elevation or capacity required. Dewatering had also to be considered. For this purpose the junction chamber was made the summit of grade. This put any necessary pumping at the main pumping stations, where, of course, it could be done most advantageously. There was also the necessity of keeping below present and also probable under-street structures. The 14-ft. tunnel was put at a depth of 80 ft. and the 12-ft. tunnel at a depth of 110 ft. No tunnel is less than 60 ft. deep. The deepest of the present city sewer tunnels is 50 ft. Future subways, so far as known, and also future sewers are

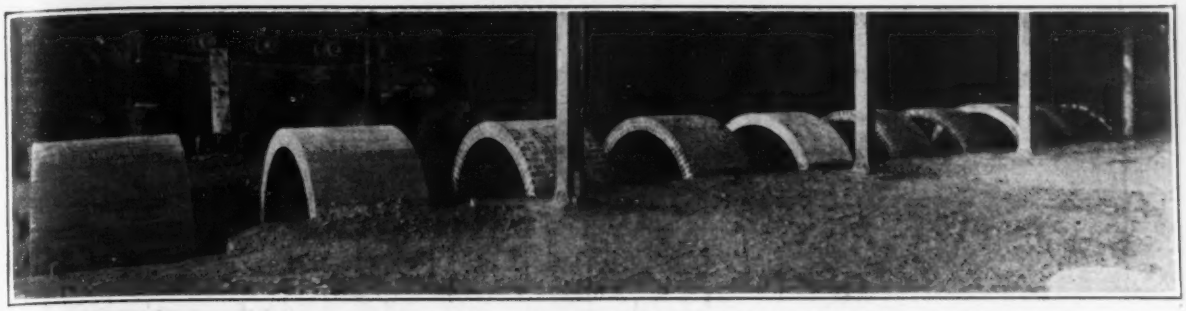


FIG. 2—PORTION OF FOURTEEN 6-FT. DIAMETER TEST RINGS OF TUNNEL LINING MATERIALS

planned for at least 20 ft. less depth than the shallowest tunnel.

Character of materials, however, had precise consideration in designing the tunnel lining. Various methods of arch analysis were compared, considering the materials and other conditions, and the elastic ring method was decided on. Stresses were then computed for various angles of repose and distributions of loadings. As grouting behind the lining was contemplated, both to fill voids and to insure watertightness, grouting pressures were taken into account. The computations indicated that extreme care must be taken in the selection of lining material and in securing high quality material, keeping in mind the desirability of utilizing local materials. With the last consideration particularly in view it was thought advisable to conduct large-size tests of various linings.

Rings 4 ft. long and 6 ft. in diameter—one-half the diameter of the 12-ft. tunnels—were adopted as standards for the test. Also a standard ring thickness of $8\frac{1}{2}$ in., equivalent to two rings of brick, was adopted. In all 14 test rings were constructed, using local common brick, 3-in. shale brick, $2\frac{1}{2}$-in. shale brick, and various mixtures of concrete of local aggregates. All rings were built in place by shaping out a trench to the springing line. Where support under only the bottom quarter was desired, the trench sides were dug away after the ring masonry had set. Load was applied to the top quarter by a method similar to that adopted by the A.S.T.M. for testing sewer pipe up to 42-in. diameter. By this arrangement rings were tested with quarter loading top and bottom and with top quarter loading and embedment to the springing line. Horizontal and vertical deflections were measured, settlement of the arch as a whole was measured and loadings at which cracking and failure took place were recorded. Supplementary crushing tests were made of concrete cylinders and of concrete piers and brick piers, 8x8x32 in., of the same materials that were used in the rings. A group of the test arches is shown by Fig. 2.

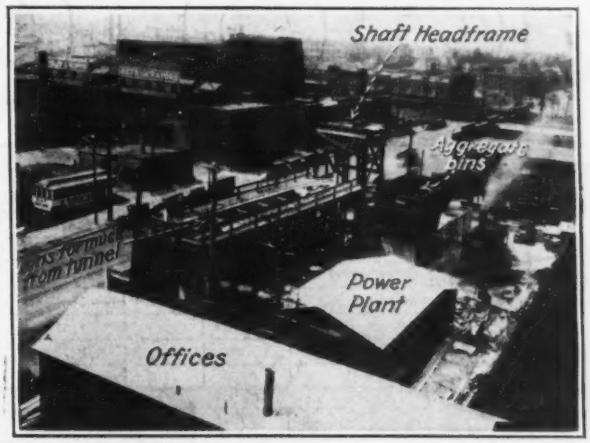


FIG. 4—TYPICAL SHAFTHEAD PLANT. SECTION 3

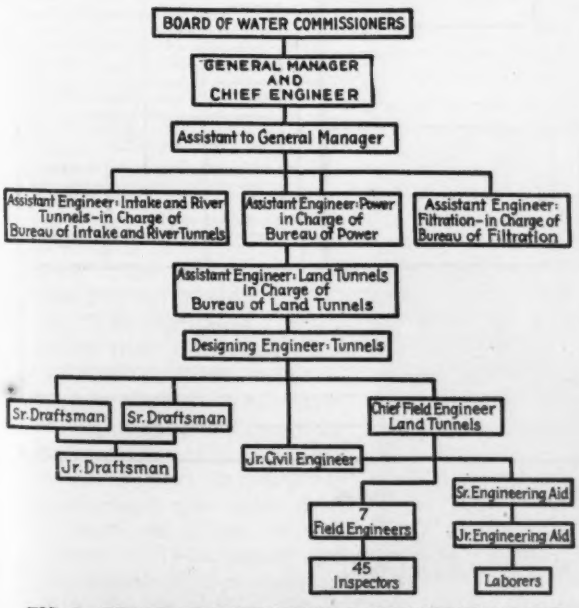

BOARD OF WATER COMMISSIONERS
GENERAL MANAGER AND CHIEF ENGINEER
Assistant to General Manager
Assistant Engineer: Intake and River Tunnels—in Charge of Bureau of Intake and River Tunnels
Assistant Engineer: Power in Charge of Bureau of Power
Assistant Engineer: Filtration—in Charge of Bureau of Filtration
Assistant Engineer: Land Tunnels in Charge of Bureau of Land Tunnels
Designing Engineer: Tunnels
Sr. Draftsman
Sr. Draftsman
Jr. Draftsman
Chief Field Engineer Land Tunnels
Jr. Civil Engineer
7 Field Engineers
45 Inspectors
Sr. Engineering Aid
Jr. Engineering Aid
Laborers

FIG. 3—CHART OF ENGINEERING ORGANIZATION FOR LAND TUNNELS

From the records of the tests and from a review of the borings, it was decided that working stresses of 667 lb. per sq.in. were allowable in vitrified brick and concrete masonry of the best quality. It was also decided that a circular section was better hydraulically and stronger when unbalanced loading was considered. Assuming an angle of repose not to exceed 6 deg., with 80 per cent of the overburden effective, a 21-in. wall thickness for most of the 12-ft. tunnel and a 25-in. wall thickness for the 14-ft. tunnel were decided on. The specifications were drawn both for brick and for concrete lining and contractors were privileged to make alternate bids on the two materials. The low bidders bid only on concrete and this is the lining being used throughout.

General Construction Plan—Engineering direction in developing the construction plan was exercised particularly in negotiating an eminently fair contract and providing a substantially common basis for bidding. To these ends the contract provided, free to the contractors, definite shaft locations and shaft plant sites. Also it required on each section definite compressed air and ventilating plant provisions. And finally it stipulated the kind of power for both shaft-head and in-tunnel equipment.

CITY OF DETROIT

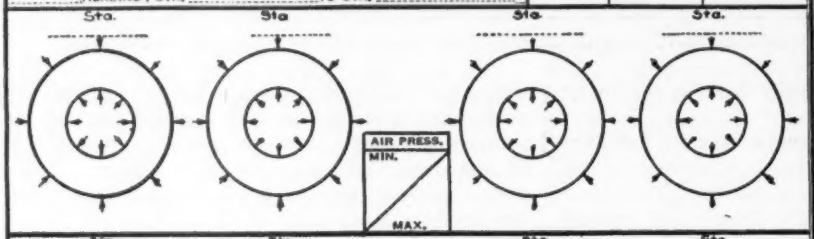
DIVISION OF ENGINEERING — BUREAU OF LAND TUNNELS

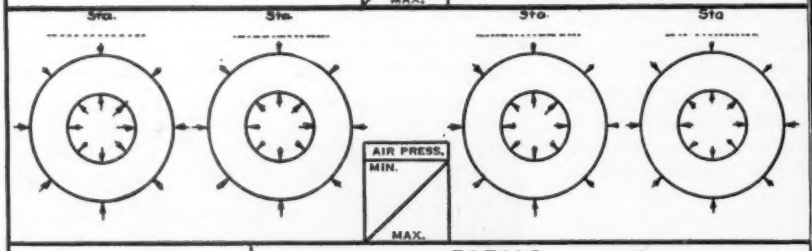
DEPARTMENT OF WATER SUPPLY

WEATHER _____ **DAILY REPORT** _____ 192____

CONTRACTOR _____ CONTRACT SEC. _____

EXCAVATION	TOTAL TO DAY	TOTAL TO DATE	TOTAL THIS EST.
____HEADING : STA.____ TO STA.____			
____HEADING : STA.____ TO STA.____			
MASONRY			
____HEADING : STA.____ TO STA.____			
____HEADING : STA.____ TO STA.____			





MATERIALS	TOTALS TO DAY REC'D	TO DAY USED	TO DATE REC'D	TO DATE USED	THIS EST. REC'D	THIS EST. USED
CEMENT (BBLS.)						
SAND (YDS. OR TONS)						
GRAVEL (YDS. OR TONS)						
TIMBER (M.B.M.)						
STEEL (LBS.)						

QUANTITIES	EXCAVATION (YDS.) TO DAY	TO DATE	THIS EST.	MASONRY TO DAY CU. YDS.	TO DAY BDLS.	TO DATE CU. YDS.	THIS EST.	GROUT (BBLS.) TO DAY	TO DATE	THIS EST.
PAY										
EXCESS										
TOTAL										

MINOR WORK ITEMS

INSPECTORS AND DISPOSITION — M TO M — M TO M — M TO M

LABOR

	CLASS	RATE	HRS.	COST
GENERAL	SUPT			
	GEN. FOREMAN			
	ENGINEER			
	TIME KEEPER			
PLANT	MASTER MACH.			
	BLACKSMITHS			
	ELECTRICIAN			
	COMP. OPERATOR			
	ENGINEERS			
	MECHANICS			
	HANDYMEN			
	TRACKMEN			
EXCAVATION	FOREMAN			
	MINERS			
	MUCKERS			
	HOIST ENG'RS			
	LOCO. ENG'RS			
	CARMEN			
	DUMPMEN			
	HANDYMEN			
	SPOILMEN			
	LOCK TENDER			
	TRUCK DRIVERS			
	LABORERS			
MASONRY	FOREMAN			
	CONCRETERS			
	MIXER GANG			
	MORTARMEN			
	LABORERS			
	LOCO. ENG'RS			
	ENGINEER			
FORMS	FORM ERECTERS			
	HELPERS			
	LABORERS			
GROUT	GROUTMEN			
	LABORERS			
	TOTAL FORCE	AVER. RATE		TOTAL COST

GENERAL REMARKS _____

FIELD ENGINEER

FIG. 5—FORM FOR DAILY REPORT ON TUNNEL WORK

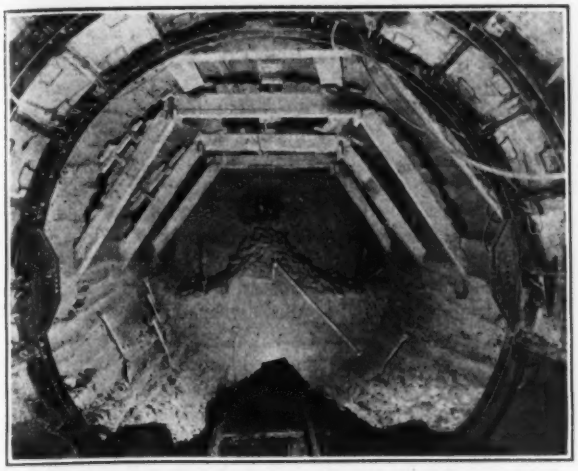


FIG. 6—CAP AND LEG TIMBERING FOR FIRM GROUND WITH HAND MINING

To cover the contract briefly: it first provides for arbitrating all disputes where time or financial considerations are involved. When changes in the work are required it provides alternative ways for determining the value of the extra work. It gives the contractor liberal rights to extensions of time and to compensation for delays or suspensions of work beyond his control or upon order of the engineers. If the contractor is delayed three months by order, or if the engineer fails to issue certificate of payment in ten days, or if the city fails to pay within 60 days, the contract provides that on seven days' notice the contractor can "terminate this contract and recover from the board payment for all work executed and any loss sustained upon any plant or materials and reasonable profit and damages." A notable clause of the contract gives the engineer access to "all books and accounts kept by the contractor." The guarantee bond is exceptional in that separate bonds in equal amount are given, one to the city "to insure construction and completion," and one to the state for "the protection of subcontractors, labor and material men."

In specifying and providing shaft sites the purpose was to keep street obstruction down by putting the structures on rented private property; to control economic location with respect to tunnel hauls, and to put all contractors on a uniform basis in bidding on this detail. The solidly built-up streets of the tunnel route offered few shaft sites. It appeared from a study of costs that 6,000-ft. drifts would be most economical. This meant 12,000-ft. sections wth middle shafts. The shaft sites were too few to make the theoretical arrangement practicable and the work was divided into one section of 14-ft. tunnel and five sections of 12-ft. tunnel as shown by the profile, Fig. 1. Four sections of the 12-ft. tunnel have a middle shaft and one (section 3) has two shafts because no shaft site could be found near the middle.

The specification of compressed air and ventilating plants for each section was to put contractors on an equal footing in the bidding and more particularly to prevent some of them from gambling with the soil to the possible hazard of the work. Chances, it was considered, could not wisely be taken with the ground conditions. The material, although generally it could be safely tunneled in free air, was uncertain enough and the tunnel line was close enough to buildings, some of them very heavy, to warrant exceeding care. The specification of compressed air plant assured means of holding the heading in any eventuality. So also ventilation was provided for on the possibility of encountering gas.

Virtually power was limited to electricity, supplemented by compressed air for special tools. The purpose was to eliminate as far as possible nuisance from smoke and from the noise and dust of gas or steam equipment. In the tunnel, of course, ventilation was a controlling reason. At shaft heads, steam plants were permitted under strict requirements as to fuel used, smokeless firing, high stacks, etc. As a matter of fact electric power was used for all shaft-head equipment except locomotive cranes and some heating boilers. The result has been almost no nuisance or complaint of noise and remarkably clean and neat shaft-head installations as shown by Fig. 4.

Specifications and Control—The requirement for compressed air plants are that they shall have at least two compressors each with a capacity of 750 cu.ft. per minute of free air at 20-lb. pressure, with duplicate pipes to the air locks and one lock in each heading. In general the contractors have installed two low-pressure and one high-pressure compressors. In the contract a lump sum bid for compressor plant was required and upon approval of the installation the contractor received payment

FIG. 7—TUNNEL BORING MACHINE WITH "HORSE COUP" TIMBERING

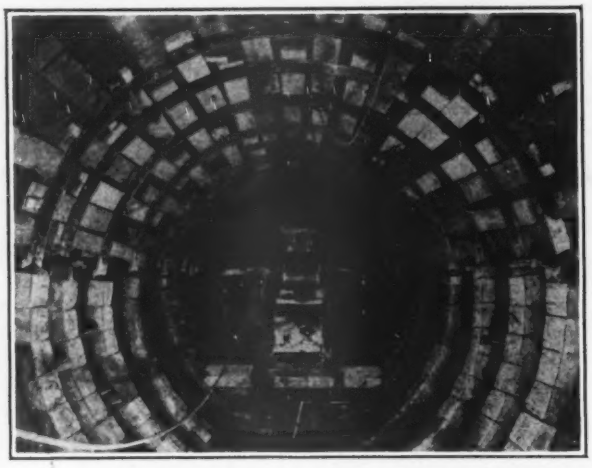


FIG. 8—T-BAR TIMBERING FOR HEAVY GROUND

amounting to 40 per cent in his first estimate; the remaining 60 per cent is paid as the work progresses in proportion to the work done.

Another requirement of the specifications was that the contractor should sink cased well-drill holes from the surface to the tunnel on the center line for use in controlling alignment. These holes are 8 in. in diameter and are spaced about every 1,000 ft. Besides their use for alignment, they have been found exceedingly convenient for taking power lines down into the tunnel and for supplying pure air for ventilation.

Chiefly, rigid specification and control are exercised in respect to lining operations. Concrete, with grouting to fill voids and make the lining tight, is being used. A rather rigid specification was adopted for concrete. An average fineness modulus of 3 with upper and lower limits of 3.25 and 2.75 is required for sand; for stone, 7.25 average, 7.6 maximum and 6.9 minimum. In addition the materials are required to be graded from fine to coarse. Even with the narrow ranges of fineness modulus there has been no trouble in securing material; so far stone has averaged 7.27 and sand 3.01 fineness modulus.

The water content is placed at 6½ gal. maximum per sack of cement and is required to be kept as small as possible. This considerable range of slump was considered desirable to meet the practical requirements of concreting behind circular ring forms; a flowing mixture is required to get the invert in and a dry mixture for shoveling into the crown. The mixture used, 1:2:3, was determined from the ring tests previously mentioned. It has proven workable, and has given excellent strength tests. To date the average strength in cylinder tests has been upward of 4,000 lb. in 28 days. The cylinders are cured 24 hours in the tunnel air and 27 days in damp sand. Three cylinders a day are molded of concrete taken respectively from invert, springing line and crown. To date the lowest strength reported is 2,600 lb., and the highest is 6,000 lb.; 89 per cent of all cylinders exceed 3,500 lb. and 97 per cent exceed 3,000 lb.

These high general results are credited as much to the careful grading of the aggregates as to any one factor. Naturally this grading allowed workable mixtures to be secured with a minimum water content. It is notable that 8- to 6-in. slumps have regularly given concrete testing 4,000 lb. In concreting the ring the wettest concrete goes into the invert and then the mixture is made drier as the wall rises, to a very dry concrete at the crown. The average of cylinders taken at invert, springing line and crown are, respectively, 4,000 lb., 4,100 lb. and 4,300 lb.

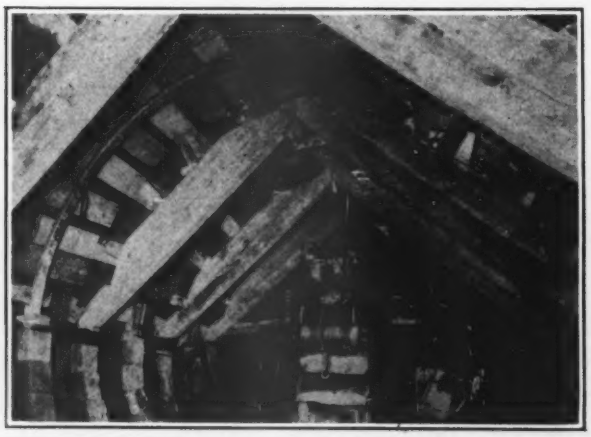


FIG. 9—COMBINED "HORSE COUP" AND T-BAR TIMBERING

FIG. 10—NEEDLE BEAM AND RADIAL TIMBERING

A check on all materials and on progress and quality of work is kept by a system of records chief of which is the daily report form shown by Fig. 5. Prepared by the field engineer, this report is a complete and official account of every day's work on each contract section.

Construction Methods—Four sections of the tunnel are in process of construction by three contractors, sections 1 and 2 being in the hands of one firm. These two sections were the first put under construction and, as shown by Fig. 1, are the farthest advanced; the methods employed are, with slight differences noted later, those employed on all contracts. Section 1 is being driven by hand-mining and section 2 by machine-boring.

The soil on section 1 has been quite uniformly a plastic blue clay with traces of gravel. Occasionally small sand seams and sand pockets have been encountered but so far have caused no serious delay. Hand-mining, working two shifts on excavation and one on lining, is averaging about 18 ft. per heading per day. A heading, with the typical three-piece timbering sets, is shown by Fig. 6. Briefly a 2x4-ft. drift is driven ahead and widened out to springing line level, leaving a bench. One shift does the drifting and widens heading and the other

takes out bench. Hand and power draw-knives and spades are the regular excavating tools, the bulk of the work being done by power draw-knives of the type long employed in Detroit sewer tunneling (*Engineering News-Record*, July 28, 1921, p. 163). These knives, as indicated by the walls of the heading, Fig. 6, take off long longitudinal shavings which break up as they fall or are cut by spades into pieces convenient for handling and are lifted by hand or are shoveled into the muck cars. These are 24-in.-gage side-dump steel cars, spotted and switched by hand and hauled in train by storage-battery locomotives.

Excavation on section 2 is by tunneling machines of the type which shaves off the face in a succession of advancing full diameter cuts much as an auger cuts a hole in wood. The cuttings go to a belt conveyor which takes them back to a tilting pan which chutes them into the muck cars. A machine in operation is shown by Fig. 7. With these machines on section 2 a progress of 21 ft. a day per heading has been kept up for several days but the average will run 2 or 3 ft. less per day operating two shifts, one excavating and one putting in lining. The ground generally has been plastic blue clay with a 2- to

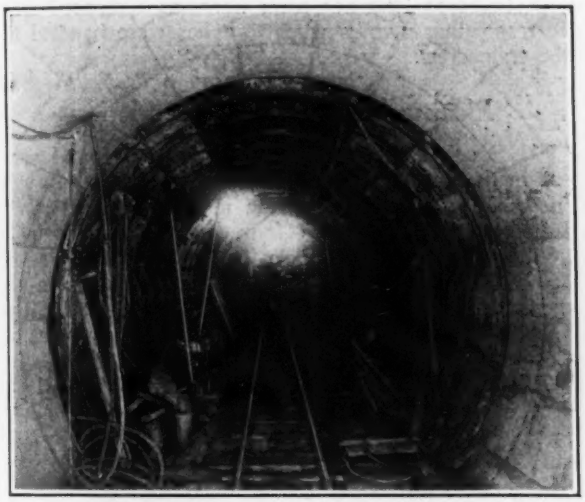


FIG. 11—LINED TUNNEL WITH STEEL FORMS SET AHEAD

6-in. sand seam at about springing line level and occasionally a few boulders.

With machine tunneling, different timbering than for hand excavation is required. The views Figs. 7 to 10 show several types. The simpler type, for exceptionally good ground, is shown by Fig. 7. Half rings of precast concrete blocks are laid on the invert and up the sides to the springing lines. On these rings are set timber A-frames, called horse coups, from which the roof lagging plank are blocked up. By this method the timber is robbed as the forms are erected, the roof lagging being blocked down to the form ribs by pipe struts as the timber sets are taken out. The possible wide spacing of the sets in good ground will be noted from Fig. 7. Fig. 8 shows the practice in quite heavy ground. Here the concrete block half-rings carry steel T-bar half rings which hold the lagging boards. The closer spacing of the rings will be noted; the lagging is laid more or less close as the ground requires. By this method both blocks and T-bars are concreted in. This is expensive. Incidentally the view shows the tunneling machine with the conveyor removed. In ground between the two extremes noted,

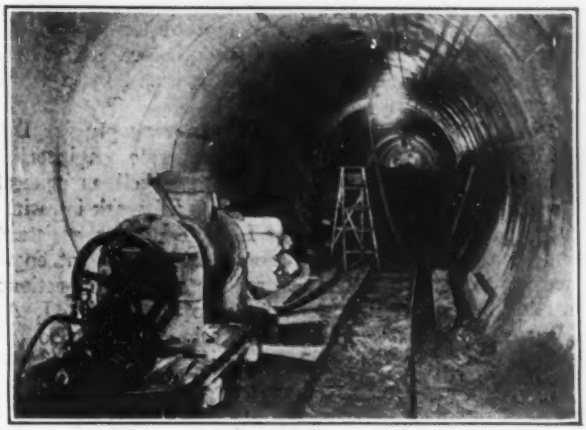


FIG. 12—GROUTING TUNNEL LINING

the combination of horse coups and T-bars shown by Fig. 9 is employed. This method saves quite an expense in T-bars.

In hand mining the simple three-piece, or cap and leg, sets shown by Fig. 6 are suitable only for firm ground. Where the soil is more unstable, a needle beam and radial timbering are commonly employed. An example of this construction from section 3 is shown in Fig. 10. The needle beam is carried on the bench and by blocking on the completed invert at the rear. In very bad ground steel liner plates are substituted for timber lagging, and are concreted in. This needle beam form of timbering has been very common in Detroit sewer tunneling; the methods were described in *Engineering News-Record*, Dec. 8, 1921, p. 940.

Muck cars in trains are hauled to the heading, hoisted one at a time on shaft cages to the level of the bin top shown by Fig. 4, and there dumped. Six-compartment bins are employed, arranged six in a row as in Fig. 4 or in three pairs with right and left chutes. The bins chute into motor trucks which take the material to dumps. The truck hauling is generally subcontracted.

Concrete lining closely follows the excavation. As soon as a section of 12 to 18 ft. has been opened up, the circular steel forms are placed and the lining is poured. The mixing is done at shaft-head plants comprising overhead bins fed by bucket elevators, stone batchers, sand inundators and ¾-cu.yd. mixers. The mixers discharge by down-shaft spouts into cars on the tunnel tracks. At the headings the steel forms are erected first to about the springing line and by means of a ramp and staging the concrete cars are dumped right or left directly over the edges of the forms. The wetter mixtures used for the bottom of the ring are spaded as thoroughly as they can be. Chief reliance for getting the concrete solidly into the bottom parts of the form is, however, put on pneumatic hammering. The inside of the steel form rings is thoroughly beaten with air hammers. As a rule the hammering has given a solid fill; very little honeycomb has shown up in the lining.

A section of finished lining, with the forms in place for sections ahead, is shown by Fig. 11. Here the fins at form joints have been cut off and these places and all other roughness have been smoothed by wetting and neat cement rubbed on with burlap sacks. All lining is grouted through pipes set in the crown at 10-ft. intervals. Fig. 12 shows the grouting operation. A pressure of 75 lb. is employed. Using a 1:1 grout the hand-excavated sec-

tions take about 0.8 cu.ft. per foot of tunnel and the machine-bored sections average 0.4 cu.ft. per foot. There is some infiltration at the joints indicated by a white incrustation of carbonate of lime.

Direction—The new additional water supply for Detroit is being constructed by a separate engineering organization headed by George H. Fenkell as general manager and chief engineer. The tunnel work is in immediate engineering charge of L. G. Lenhardt, assistant engineer, land tunnels, and Torris Eide, assistant engineer, river tunnels. The contractors are: For sections 1 and 2, George R. Cooke Co.; for section 3, J. A. Mercier Co., and for section 4, Mark R. Hanna Co.

Switch Control Expedites Traffic on Single-Track Railways

WHEN traffic on a single-track railroad reaches a point approximating chronic congestion, the most obvious remedy is to provide a second track, forming a double-track line of such length as may be necessary for adequate traffic capacity. But the investment cost in the second track is heavy and involves large fixed charges, while it is probable that only occasionally will this track be really necessary.

Movements of freight trains may be hampered seriously at certain points by continual delay and interference due to the necessity of holding them on sidings to clear passenger trains or other superior trains. At the same time the volume of traffic may not warrant the expense of double-tracking. Since the freight trains are the most numerous, the problem is to find some way of facilitating their movements without incurring the expense of a second track. Trouble of this kind on any busy single-track operating division may be minimized by a careful study of the troublesome points and the traffic conditions, making such changes in sidings or location of coal and water stations as may seem desirable, and installing an adequate block signal system to expedite and protect train movements.

This problem of moving heavy traffic expeditiously, economically and safely on single-track lines has been studied thoroughly by B. H. Mann, consulting signal engineer of the Missouri Pacific Ry., who has presented his studies and conclusions in a recent pamphlet. In particular he points out that lap sidings may be introduced to permit trains to pass without stopping, under protection of the signals. Then the switches may be handled by the station operator, using mechanical connections for the near switch and electric remote-control apparatus for the outer switch.

This method of operating will eliminate the delays due to trains having to stop on the main line while a brakeman goes ahead to open the switch and let the train pull into a siding. Such delays average five minutes, including the stopping of the train, the operation of the switch and then the slow movement of the train in pulling into the siding until it is clear of the switch. On the open line a freight train at 20 m.p.h. will travel a mile in three minutes. Then the 5-minute delay may be avoided either by building a mile of second track, costing perhaps $40,000 to $60,000 in the central-west country, or by installing remote-control apparatus for the switch at a cost of about $6,000. By such simple methods, properly applied, a single-track line may be made equal to a double-track line in its production or output of gross tons per train-hour.

REDUCTION IN TRAIN DELAYS

	One Day		One Day	
	Before	After	Before	After
Trains, number	12	11	11	11
Total tonnage	17,386	21,012	28,756	28,106
Tons per train, average	1,449	1,910	2,605	2,558
Time per train, average	4h. 10m.	3h. 36m.	4h. 36m.	2h. 54m.
Delays, number	35	29	29	20
Delays, total time, minutes	843	584	880	263
	One Month		One Month	
Trains, number	696	598	728	663
Speed, m.p.h., average	9.19	10.91	9.81	12.03
Gross ton-miles per train-hour	16,983	21,528	18,499	22,370
Coal per 1,000 gross ton-miles	190.7	163.5	197	174

In his pamphlet, Mr. Mann gives the detailed results of such a system of what he calls "scientific railroad operation," as applied to a 56-mile single-track subdivision of the Missouri Pacific Ry., equipped with the controlled-manual block system. These results are summarized in the accompanying table, which gives figures for periods before and after the switch-control apparatus was installed. In the latter case, time lost in daily delays on the road was reduced about 30 and 70 per cent, and the running time was thus reduced materially, so that two record months showed reductions of 26.8 and 21 per cent in gross tons per train hour, as compared with corresponding months when switches were handled by the train crew.

Placing a Lighthouse Foundation

THE subfoundation for Lansing Shoal Lighthouse, in the northern part of Lake Michigan, which was successfully sunk into position in 25 ft. of water on July 24, 1927, consists of four concrete caissons built by the United States engineers at Milwaukee and towed 250 miles to the site. The following information on the placing of this foundation was reported by the Lighthouse Service of the United States Department of Commerce:

Each caisson was 20 ft. wide, 54 ft. long, and 21 ft. deep. The four were placed so as to form a hollow square 74 ft. outside dimensions and 34 ft. inside. Each caisson was divided into four pockets by means of cross walls, and weighed about 500 tons. When launched they floated with about 6 ft. freeboard. In transit, double plank covers were bolted to their open tops to protect them from shipping seas. One tender took two of the caissons in tow, the caissons being spaced about 300 ft. apart.

Arriving at the site, the caissons were placed in position, tied together with tension rods, and sunk by filling them with water. A bed of riprap about 4 ft. thick had been placed to receive them. The caissons were then united at the bottom of the inside 34 ft. square space by a reinforced concrete slab 2 ft. thick, the concrete being deposited through a tremie. They will later be united at the top by a reinforced-concrete slab 7½ ft. thick and 74 ft. square, forming the floor of the basement. For a distance of about 6 ft. above and below the water line, steel plates and channels were placed to protect the caissons and the capping slab from ice which is present in large quantities for a several month period. After pouring the 2-ft. concrete slab in the bottom, the interior of the caissons and the center space were filled with 7-in. stone delivered by a belt conveyor self-unloading steamer delivering 7,200 tons in 4 hr. The caissons and center space took 4,200 tons, and the balance was placed as a protective riprap around the caissons, to be covered later with larger stone.

Heat Changes During Setting of Alumina and Portland Cements

Tests Show Temperature of Alumina Cement Mix Four Times That of Portland and Heat Generated Twice as Great

By A. A. Jakkula
College of Engineering and Architecture, University of Minnesota, Minneapolis

THE SETTING of any cement is chiefly a chemical action, and is accompanied by heat. Alumina cement in its setting behaves so differently from portland cement that tests were recently made to determine the heat developed and the temperatures reached by specimens of alumina cement during this period. These tests, which are reported in this article, were made on 6x12-in. cylinders.

Testing Apparatus—The temperature tests were run in a box made of ¾-in. white pine lined with 1 in. of

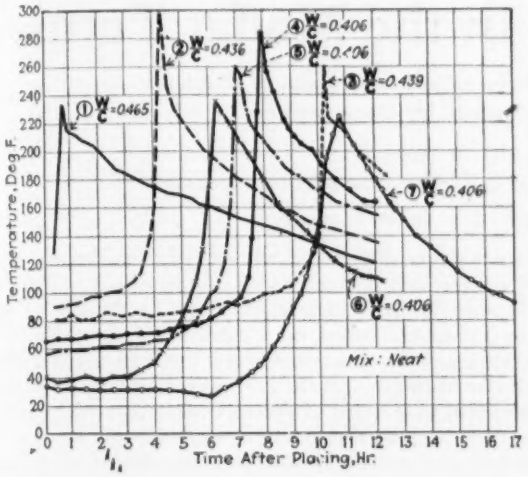


FIG. 1—TEMPERATURE CURVES OF NEAT ALUMINA CEMENT USING VARIABLE INITIAL TEMPERATURES

flaxlinum insulating material and heated by six electric light bulbs placed in the bottom. The intensity of the heating was regulated by rheostats. Temperatures in the specimens were measured by three copper-constantan thermocouples placed in the specimens and a portable potentiometer pyrometer indicator with automatic cold-junction compensator. The insulated box was chosen so that any heat generated could not escape, since that is the condition that exists in the interior sections of concrete because of its good insulating properties.

The heat-generation tests were run in a calorimeter consisting of two galvanized iron cans, one within the other, separated by 1½ in. of granulated cork. The specimen container, likewise of galvanized iron, rested on wooden supports within the innermost can, and was surrounded on all sides by 1 in. of water. The rise in temperature of this water was measured by means of two accurate thermometers.

Measuring Temperatures—For the first of the temperature tests, seven cylinders were run, using varied initial temperatures. The results are shown graphically in Fig. 1. The tests 1, 2 and 3 were run with cement from one batch, and 4, 5, 6 and 7 from a second batch. The cement and water were first heated to the initial

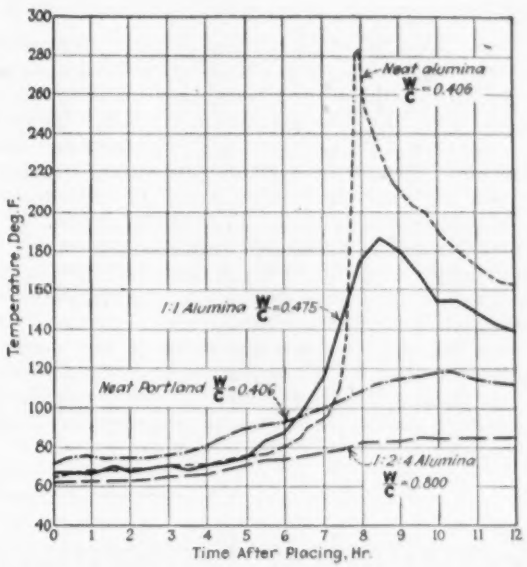


FIG. 2—TEMPERATURE CURVES OF VARIOUS MIXES USING THE SAME INITIAL TEMPERATURES

temperature desired, then mixed and placed in forms in the box, which in the meantime had been heated to the selected temperature. As soon as the temperature of the specimens started to rise, the lights were turned off. The lower temperatures were obtained by taking advantage of cold weather during January.

In Test 1, Fig. 1, the cement and water were heated to 130 deg. F. Before the mixture was placed, it had started to set. During the tests the rapid rise in temperatures and the boiling of excess water on top of the test cylinders were especially noted. In Test 7, although the temperature as indicated by the thermocouples was below the freezing point of water, there was evidently

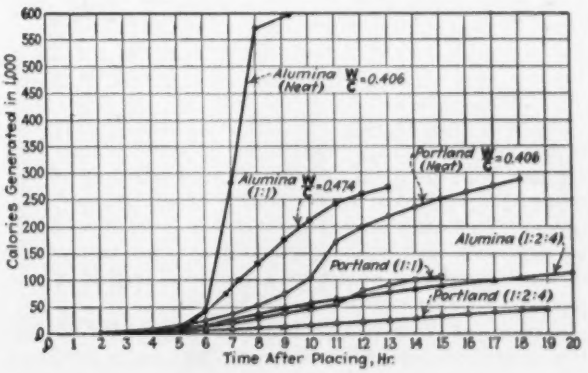


FIG. 3—COMPARISON OF HEAT GENERATED BY VARIOUS MIXES OF ALUMINA AND PORTLAND CEMENTS

enough free water to start the action, since the specimen reached a temperature of 223.2 deg. F. The water cement ratios *W/C* for each mix are given on all of the accompanying graphs.

In Fig. 2 are shown the results of three tests using approximately the same initial temperature but with a neat, a 1:1 and a 1:2:4 mix. There is also shown, for comparison, a graph for a neat portland cement specimen.

Measuring Heat Developed—The results of the calorimeter tests show the heat generated by different mixes.

In these results, given graphically in Fig. 3, corrections have been made for radiation and for the heat absorbed by the calorimeter and its contents. Readings were continued until the temperature of the water began to drop, but since the specimens were still generating heat, which was dissipated by radiation, the curves continued to rise. Readings were taken every 15 minutes, but only enough points are shown to draw the curves.

Conclusions—While the test runs are not enough in number to justify any sweeping statements as to the behavior of alumina cement during setting, the following conclusions are supported by these tests:

(1) When the specimens are made of neat alumina cement of average consistency, and are confined so that the heat generated cannot escape, a temperature above the boiling point of water may be expected, due to the chemical action of setting and hardening.

(2) A decrease in the richness of the mix reduces the temperature rise.

(3) Fig. 2 indicates that the alumina cement specimen reached a temperature four times that of a similar portland cement specimen.

(4) The rise in temperature with alumina cement takes place very suddenly. In every instance a rise of over 100 deg. F. took place in approximately 15 minutes.

(5) A high initial temperature causes quick setting of an alumina cement mix.

(6) In all cases, for the same mix and the same water-cement ratio, the specimens composed of alumina cement generated over twice as much heat as similar specimens of portland cement.

(7) At initial temperatures below 80 deg. F., the temperature of a concrete using alumina cement will start to rise in about 5 hours.

Ventilation Experiments in the Moffat Tunnel

Determination of Air-Flow Friction Factors as Basis for Design of Plant for Removing Gas and Smoke Discharged by Locomotives

By G. E. McElroy and C. A. Betts

Mining Engineer, U. S. Bureau of Mines, and Designing Engineer, Moffat Tunnel Commission

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PREVIOUS to the completion of the six-mile Moffat tunnel through the Continental Divide, in Colorado, it was necessary to decide on specifications for fans to ventilate the tunnel for operation by steam locomotives, as determined upon by the Denver & Salt Lake Railroad, lessee of the tunnel. This single-track tunnel, 32,250 ft. long, has an average cross-section of approximately 400 sq.ft. It has grades of 0.8 and 0.9 per cent from the west portal to an apex near the center, and 0.3 per cent from the east portal to the apex. The east portal, El. 9,200, is 115 ft. higher than the west portal. Approximately half of the tunnel will have heavy timber or steel lining, while in the remaining half the rock walls stand well without support. To determine the requirements for mechanical ventilation, it was necessary to estimate both the volume of flow desired and the pressure required to circulate this quantity of air through the tunnel. In both of these estimates a large number of variables are involved. Fig. 1 shows the method of measuring velocity of air in a timbered section of the pioneer or water tunnel.

Volume of Flow—The primary purpose of the ventilation is to dilute and remove the noxious gases produced by combustion of coal in the engine. A secondary purpose is to reduce the otherwise high temperature in the engine cab. Ventilation requirements are based on diluting the carbon monoxide of the locomotive exhaust gas to a proportion that would have a negligible effect on man. It was estimated that the maximum quantity of air required for dilution to 5 parts per 10,000 would be 360,000 cu.ft. per minute for a 50-car train with one locomotive traveling at 10 m.p.h. up a grade of 0.9 per cent. This is assuming 24 lb. per ton for tractive resistance; coal consumption, 0.73 lb. per second; 25 lb. of flue gas averaging 1 per cent CO per pound of coal, and weight of air at 0.055 lb. per cubic foot.

Pressure Requirements—The pressure required to cause any given volume of air to flow through an airway depends on the dimensions, velocity of flow, density of air and the physical characteristics of the airway. This last item must be handled in calculations by the use of empirical numbers based on experimental determinations and designated as friction factors. Such factors for mine airways 40 to 60 sq.ft. in area were available, but their application to airways of 400 sq.ft. was extremely uncertain, as was also the available evidence concerning the effect of area on friction factors. In view of these facts and of the rough rock surfaces, it was considered necessary to determine friction factors for typical sections of the tunnel. The tests indicated that a maximum average value of the friction factor for air weighing 0.055 lb. per cu.ft. would be about 0.000,000,005.

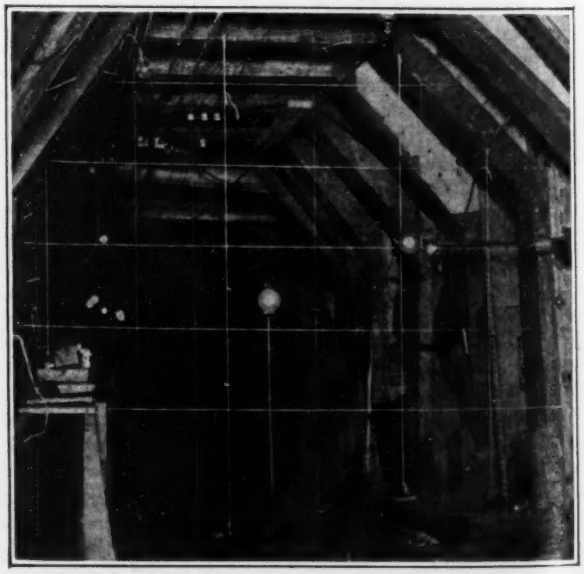


FIG. 1—MEASURING AIR FLOW IN TUNNEL

Tunnel Resistance—The resistance of the clear tunnel was calculated at 5.03 in. of water by dividing the product of the friction factor, the average perimeter of tunnel section in feet, the length of tunnel in feet, and the square of the estimated quantity of flow in feet per minute, by the product of 5.2 and the cube of the tunnel area. The resistance of the fan connection to the tunnel was similarly calculated at 0.02 in. of water.

Tunnel engineers advocate trains moving against the air flow. No data being available for the resistance caused by moving trains, the resistance of a standing train

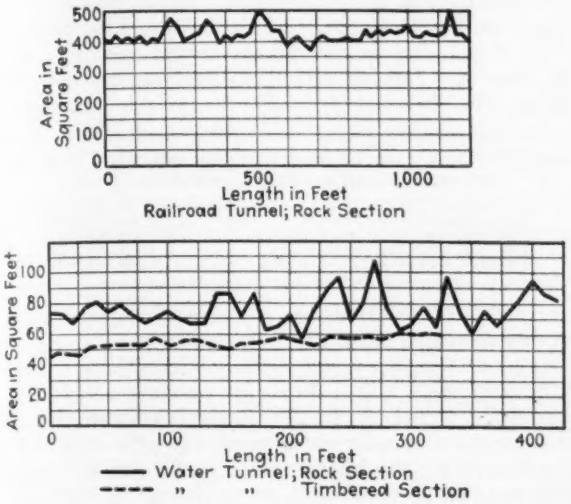


FIG. 2—AREAGRAPHS OF TEST SECTIONS OF TUNNELS

was first calculated from experimental data and from rational assumptions. The difference in results was then used in arriving at the resistance of a moving train calculated by the latter method. Experiments with coal-mine cars occupying about 20 per cent of the total area gave an end resistance of 0.45 of the velocity pressure in the clear airway for the first car, and 0.15 for the side resistance of each additional car when closely coupled. Tests on single cars of different areas indicated that the resistance varied directly with the square of the ratio of car area to airway area. Assuming the locomotive equal to two cars, an average train of 50 cars, and cars approximately 125 sq.ft. in section (thus occupying about 31 per cent of the 400-sq.ft. tunnel area), the total train resistance may be calculated at 0.734 in. of water.

The resistance of the standing train may also be calculated by considering it made up of two components: The impact against the end and the increase in resistance due to the air moving at higher velocity through the reduced section. On this basis the total train resistance is 1.018 in., or 40 per cent higher than the 0.734 in. calculated from experimental data. Since rational computations approximate experimental results for standing trains, a sufficiently accurate calculation of the resistance caused by the train moving against the air flow at 10 m.p.h. may be made. Assuming that the values thus calculated are 40 per cent high, this resistance was determined as 1.31 in. of water.

On the basis of a required flow of 360,000 cu.ft. per min. we have calculated the total resistance to flow of air as follows: 5.03 in. for the tunnel proper; 0.02 in. for the fan connection; and 1.31 in. for a train moving 10 m.p.h. against the flow. The total is 6.36 in.

Natural Draft—The barometric pressures at the two portals are rarely the same, due to differences in atmospheric conditions on opposite sides of the mountain. Barometric records indicate that there will be a strong draft from west to east during the winter, and a variable draft with frequent reversals during the rest of the year, west to east predominating during spring and fall and east to west during the summer. The average maximum draft west to east is about 4.1 in. of water, which is rarely exceeded and only for relatively short periods. The maximum record is 9.5 in. The average maximum draft east to west is about 0.7 in. of water, which is rarely attained. The maximum record is 2.0 in.

Two minor components are: (1) Difference in weights of the air column inside of the tunnel and that at the west portal through the same elevation; and (2) effect of wind pressure on the portals. The former amounts to but 0.11 in. for 40 deg. average difference in temperature between the inside and the outside of the tunnel, an extreme winter condition of rather short duration. Gales are frequent during the winter, blowing against the west portal and down over the east portal, the latter probably producing some suction effect. At 40 m.p.h. the wind pressure on the west portal might be as much as 0.6 in. This, added to some suction on the east portal, would make the possible wind component of some importance. Therefore, natural draft pressures will play an important part in the ventilation of the tunnel and in a way that increases the maximum demand on the ventilating equipment, since during the winter the fan must act against strong adverse natural draft when blowing against heavily loaded trains moving west to east up the grade.

Experimental Determinations—Some experimental determinations of friction factors in the uncompleted tunnel were made to provide a reliable base for estimating the tunnel resistance. These tests were made in March, 1927,

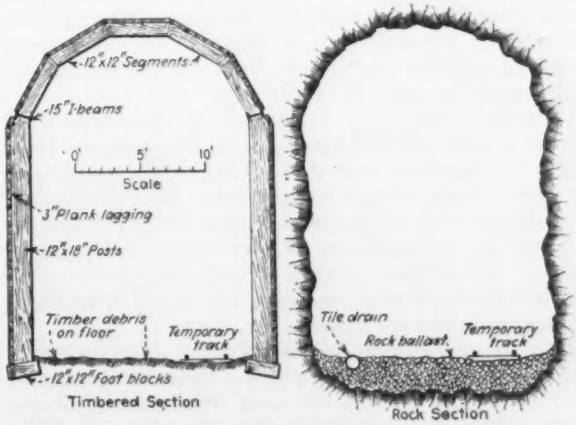


FIG. 3—MOFFAT RAILROAD TUNNEL SECTIONS

shortly after the parallel pioneer or water tunnel had been holed through, the pilot bores of the railroad tunnel being then about 1,000 ft. apart and the enlargement headings about 4,800 ft. apart. As the tests were made during active tunneling operations only about 20 per cent of the observations escaped operating interference.

Four test sections included a rock section and timbered section of both the railroad tunnel and the pioneer or water tunnel. The averages of a large number of test observations seem quite reliable and check almost exactly with previous estimates from other experimental data.

As a result of these tests, friction factors given in the accompanying table were selected as applicable to such large airways. These factors, for use in formulas for flow of air, are constants representing the influence of roughness on pressure requirements and they vary directly as the air density.

Test Methods—The determination of friction factors involves the simultaneous measurement of the air flow and the difference in static pressure between the two ends of the test section, with sufficient observations of barometric pressures and temperatures for determining the weight of air. Under the test conditions, air measurement by calibrated anemometers was considered more practical than Pitot tube or velocity-pressure methods. Air flow was measured at a timber set in a heavily timbered section of the water tunnel. Preliminary traversing, as shown in Fig. 1, determined the relation of the mean velocity to the velocity at the center of the section and the latter

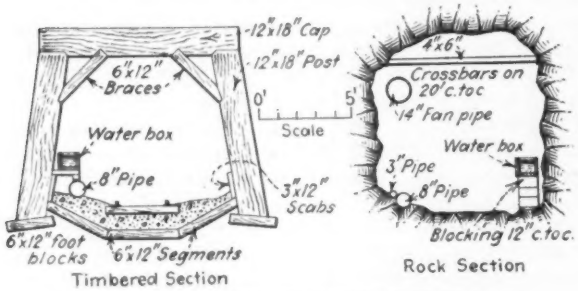


FIG. 4—SECTIONS OF PIONEER TUNNEL
Note obstructions to air flow.

only was measured during pressure-loss tests. The intersections of the strings show the traverse or measuring points for the anemometer. A few center velocities measured simultaneously by anemometer and Pitot tube were about 2 per cent higher by the latter method, which, considering the difference in areas of the instruments involved, is ample assurance that the anemometer calibrations used were substantially correct.

Standard static tubes of Bureau of Mines type were set up at each end of the test section and pressures from these were communicated through three-eighths-inch hose to a pressure gage located near the middle of the section. The difference in the pressures communicated through the tubings was measured by Wahlen differential pressure gages. Temperatures in the tunnel were almost absolutely constant at any one point, but varied from 58 to 65 deg. F. in the test zone.

Results of Tests in Railroad Tunnel—The rock surfaces of the test section were of less than average roughness for blocky granite, but were representative of average conditions for untimbered sections throughout the tunnel. Area variations were quite large, but without abrupt transitions, as is shown by the areagraphs in Fig. 2. The floor was ballasted and but slightly rougher than the completed tunnel condition. Fig. 3 shows a representative cross-section. Good agreement of average results was secured, the average value of the factor being 0.000,000,007 for velocities of 57 to 83 ft. per min.

In the timbered section, the faces of the 12-in. timbers were in almost absolute alignment but the spacings varied irregularly. About half the length of the section had 3-ft. spacing, which was the average for the finished tunnel. The floor was level but littered with wood débris. Fig. 3 shows a typical cross-section. Here the tests gave somewhat erratic results and the average of 0.000,000,0053 at 74 to 81 ft. per min. may be somewhat high.

Results in Pioneer Tunnel—In the timbered section, Figs. 1 and 4, the faces of the 12-in. timbers were in good alignment and the sets were 18 and 24 in. c. to c. Areas were taken inside of the upper braces, with no allowance for the space between these braces and the caps, as tests show that no appreciable flow occurs through such small openings. Tests gave average factors of 0.000,000,0052 at velocities of 250 to 700 ft. per minute. Below 250 ft. per min. the factor increased rapidly, and was 0.000,000,0073 at 171 ft. per min. In the rock section, Fig. 4, the surfaces were more irregular and the changes more abrupt than in the railroad tunnel (see Fig. 2); the floor was rougher and there were several obstructions. For velocities above 250 ft. per min. the factor averaged 0.000,000,0148, but it increased rapidly as the velocity decreased below 250 ft. per minute.

VALUES OF FRICTION FACTOR IN LONG STRAIGHT TUNNELS FOR AIR WEIGHING 0.075-LB. PER CUBIC FOOT

Unlined rock	0.000,000,0070
Timbered sets 4 to 5 ft. c. to c	0.000,000,0060
Timbered, sets 3 ft. c. to c	0.000,000,0055
Timbered, sets 2 ft. c. to c	0.000,000,0020
Timbered, skin to skin	0.000,000,0014

Effect of Roughness and Velocity—Experiments show that for airways with a degree of roughness similar to the Moffat tunnel the friction factor is constant for all air velocities ordinarily encountered. In estimating friction factors for the Moffat tunnel section of 400 sq.ft., from tests on 40 to 60 sq.ft. mine airways of the same degree of roughness, the difference between absolute similarity and geometrical similarity had to be estimated. From rather scanty data the accompanying decrease in factor was estimated at about 25 per cent. The tests on the railroad rock section confirm this result, if the assumption is made that the determined factors are not influenced by low-velocity flow.

No data for low-velocity flow in rough airways were available except recent English tests on an 8x8-ft. timbered mine airway at velocities of 15 to 350 ft. per minute. From the theory of fluid flow no change in flow would be expected in this range, but the tests showed a decided change at about 300 ft. per min., the friction factors increasing rapidly as the velocity was lowered beyond this point. In the present tests, the results in the small pioneer bore show a similar break in the law of flow at about 250 ft. per min., but the results in the railroad tunnel indicate that the effect of low velocity on the friction factor is negligible for such large areas.

Effect of Timber Spacing—This influence on the friction factor has never been investigated thoroughly. Coal mine experiments show a 25 per cent decrease for 10-ft. as compared with 5-ft. spacing, and metal-mine data are mainly for 5.3-ft. spacing. The average spacing in the Moffat pioneer tunnel timbered section was 1.8 ft. and determined factors for this section are about 35 per cent lower than factors determined for metal mine airways having 5.3-ft. spacing. In the application of these data to the timbered railroad tunnel, with average spacing of 3 ft. c. to c., some reduction of the factor for 5.3-ft. spacing is indicated both on the basis of absolute spacing and on the basis of geometrical ratios, but quantitatively the result can only be roughly estimated as possibly about 10 per cent. More data are needed on the interrelated effects of area, low-velocity flow and timber spacing as relating to friction factors.

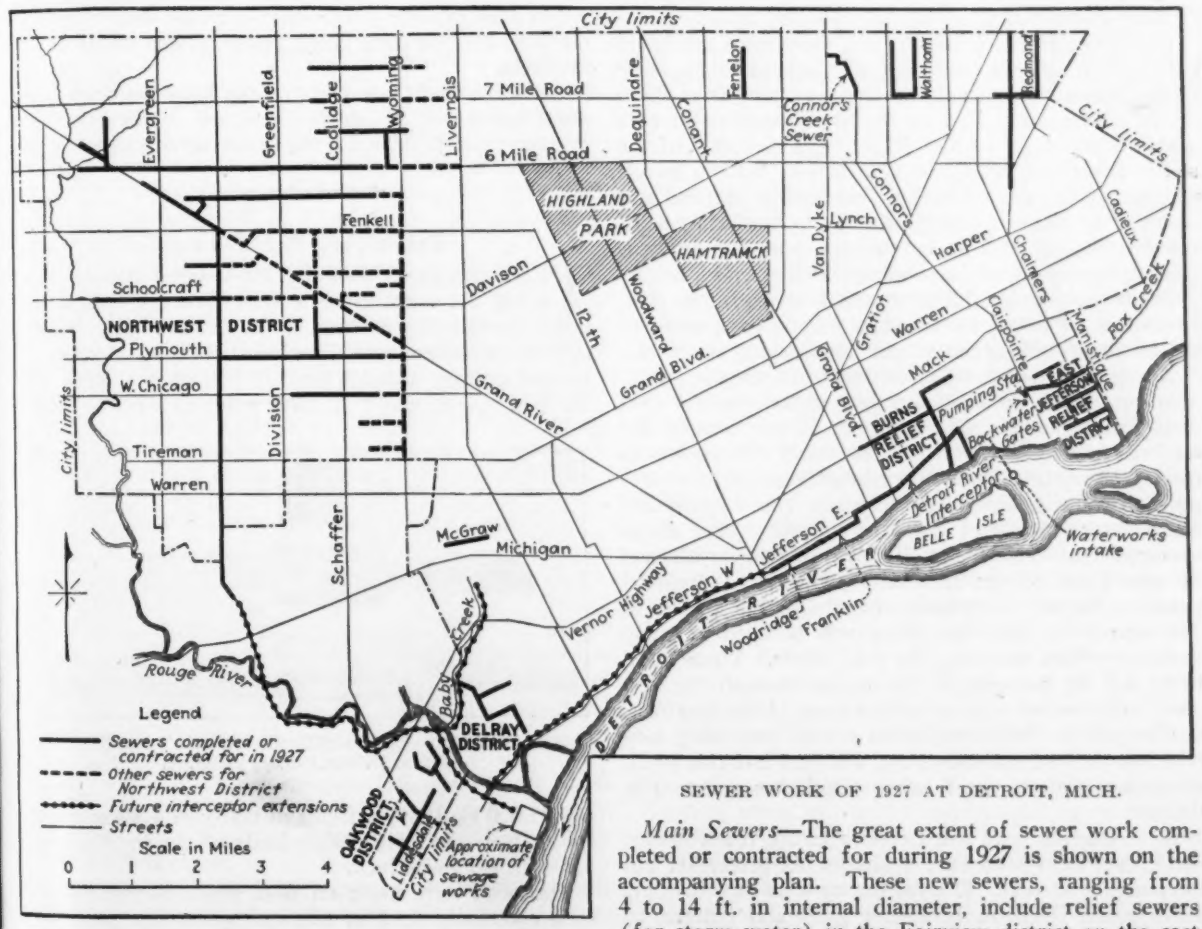
These tests were made by the U. S. Bureau of Mines at the joint request of the Moffat Tunnel Commission and the Denver & Salt Lake Railways. Special appreciation is due to E. H. Denny, supervising mining engineer of the Bureau of Mines, and to K. L. Marshall, R. F. Sopris and H. R. McGrury, as engineers of the Bureau, the railroad and the commission respectively.

Progress on Large Sewerage Program at Detroit

Building 325 Miles of Large and Small Sewers and Electric-Driven Pumping Station at Cost of $11,000,000

A PROGRAM of $11,000,000 for sewer work at Detroit, Mich., during the year 1927 marks an exceptional activity in extending the city's sewerage system into districts hitherto dependent upon county ditches for their storm drainage. Of this amount $4,008,500 and $3,338,500 were allotted for new sewers on the west and east sides respectively; $1,500,000 for storm drains to catchbasins on new street paving; $400,000 for laterals and small branches, and $1,243,000 for miscellaneous items and the maintenance of pumping stations. This year's program will establish a record in Detroit sewer construction. In addition to the 42 miles of large sewers and the 172 miles of lateral sewers, the maintenance division of the Department of Public Works will construct more than 100 miles of storm drains to serve the new pavements. Sewer construction for the past three years has eclipsed any former five-year period. The present area of the city is nearly 140 sq. miles and the total length of both mains and laterals is 2,060 miles, representing a total value to the city of $98,000,000.

For several years Detroit has faced the problem of extending its sewerage system to serve the rapidly increasing population which is building up outlying districts and newly-annexed territory. Another problem is that of improving the older part of the system. This latter work includes new trunk sewers, relief sewers to carry storm water and thus relieve the old combined sewers, and intercepting sewers to eliminate sewage discharge near the water-works intake. Some of the new trunk sewers are of great size, such as the Connors Creek sewer, the lower portion of which is of triple box section with each compartment 15¾ x 17½ ft. A review of this development, together with a lengthy review of the Detroit sewer construction program as it then stood, was given in *Engineering News-Record* of Nov. 2, 1922, p. 745.



SEWER WORK OF 1927 AT DETROIT, MICH.

Main Sewers—The great extent of sewer work completed or contracted for during 1927 is shown on the accompanying plan. These new sewers, ranging from 4 to 14 ft. in internal diameter, include relief sewers (for storm water) in the Fairview district on the east and the Delray district on the west side. Up to November, 1927, there had been 58 contracts let aggregating $8,100,000 and covering a total of 222,000 lin.ft. Most of this work is in tunnel, through soil varying from hard blue clay to soft clay and fine wet sand. The material used has been either concrete or brick. On the tunnel contracts, shafts were 500 to 2,000 ft. apart. Thousands of yards of clay and sand have been taken from these tunnels and deposited in depressions, swampy land and otherwise unused property.

Exceptional conditions or difficulties have necessitated special methods in some cases. On Liddesdale Ave., in the former village of Oakwood, a 9-ft. tunnel is being driven at an average depth of 30 ft. through extremely soft ground. Here it was necessary to use a shield, the progress of which raised the surface of the ground, leaving on each side a ridge about 2 ft. high. This work was done by the construction division of the Department of Public Works, whose bid was lower than that of any contractor.

On the Southfield Ave. sewer, five contracts were let last year, each for one mile of 10-ft. tunnel, and on four of these sections the work was in fine water-bearing sand, necessitating the use of compressed air and the grouting of the soil to hold the pressure. It was even necessary to grout the original test borings which extended through the overlying clay. A vein of natural gas was struck, resulting in a serious explosion. This year the soil conditions have been more favorable. This sewer will connect with a future interceptor following the course of the Rouge River and extending to the proposed treatment works near its mouth, as noted below.

On the east side, where several main arms are being extended to serve territory east of Connors Creek, some of this work is in open cut at depths varying from 20 to 35 ft. Excavation is done by large draglines in cuts whose width often reaches 50 ft. The character of the soil is favorable for sewer construction, both in tunnel and open cut, except where a few pockets of sand and seamy clay have retarded progress. A much needed relief sewer, 13 ft. 9 in. in diameter, placed under contract to serve a district east of Grand Boulevard, has its outlet in the Detroit River at the foot of Burns Ave. From this tributary, feeder arms will be constructed to cut off the overburdened sewers now serving this area.

An extension of the Detroit River interceptor, 12 ft. 3 in. and 13 ft. in diameter, now under contract (see map), will complete approximately 25 per cent of the total distance to be covered. This sewer eventually will convey the entire city's dry-weather sewage to a proposed treatment plant near the westerly city limits and south of the mouth of the Rouge River. (See *Engineering News-Record*, Jan. 21, 1926, p. 112, for abstract of report on sewage treatment project.) Additional pumping capacity completed recently in the station at Jefferson and Clairpointe Aves. will be used to pump storm overflows from the old 9-ft. sewer. These overflows will be conveyed to the station through the new 14-ft. relief sewer now completed from Manistique Ave. to Clairpointe. Additional relief sewers now being constructed south of Jefferson Ave. will feed into this 14-ft. barrel and prevent the flooding which has occurred in the past.

In connection with the Connors Creek trunk sewer, two interesting features are the backwater protection and the pumping station. The former consists of a forebay, sluice gates, 10x10-ft. backwater gates and tailrace, to prevent the Detroit River from backing up into the sewer. It will thus permit the diversion of dry-weather flow into the Jefferson Ave. sewer. When this work is completed practically all Detroit sewage will be discharged below the water-works intakes, both of which are above Belle Isle. The pumping plant for discharging storm water from the East Jefferson Ave. relief sewer into the Conners Creek sewer will consist of eight electrically driven vertical units each having a capacity of 500 sec.-ft. against 27-ft. head. A contract has been let for the first four units.

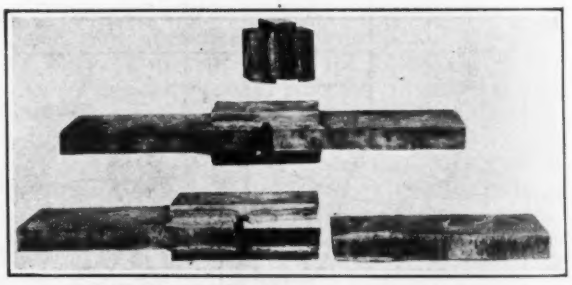
Lateral Sewers—In addition to the main sewer work, approximately 162 miles of lateral sewers, comprising 171 contracts at a total cost of over $2,400,000, have been placed under contract since Jan. 1, of which approximately 140 miles have been completed. This work is distributed over the entire city and is being done for the most part in open cut by trenching machines. An average day's work for such a machine in a trench 10 to 16 ft. deep is 300 lin.ft. Vitrified clay pipe and concrete pipe from 12 to 24 in. in diameter are being used. These sewers are located in alleys or easements and join the main sewers at street intersections.

An additional 10 miles of lateral sewers will be let before the end of 1927. These will cost approximately $120,000 and will bring the total length for the year up to 172 miles. In some instances where main sewers are not available as outlets for lateral sewers, temporary pumping stations have been constructed to lift the sewage into county ditches after it has been passed through septic tanks. Considerable work has been done on the maintenance and excavation of these county ditches, which must provide storm-water drainage in the extreme outlying districts until public sewer service can be made available.

All these works are parts of the large sewerage program being carried out under Perry A. Fellows, city engineer, and J. W. Reid, commissioner of public works.

Fillet Arc-Weld Tests

TEST specimens made by the General Electric Co., using the metallic-arc welding process, and tested under the direction of Prof. T. R. Lawson in the laboratory of the Renssalaer Polytechnic Institute, Troy, N. Y., showed average ultimate loads in pounds per lineal inch for $\frac{1}{4}$-in., $\frac{5}{16}$-in. and $\frac{3}{8}$-in. fillet welds of 10,500, 12,000



ARC-WELDED TEST SPECIMENS AFTER FAILURE IN TENSION AND COMPRESSION

and 13,000 lb. Using a factor of safety of 4, these results afford safe allowable design loads of 2,600, 2,900 and 3,200 lb. per lineal inch.

The tests were made on fillet welds as the type of weld commonly used in fabricating machine parts and other structural steel details. On each specimen there were made tension and compression tests, the fillet lengths being $\frac{1}{2}$, 1, 2, 3, 4, 5 and 6 inches.

The welds tested were all made by hand, the entire fillet being built up in a single pass along the joint. In summarizing the results, values were used representing the lowest average of test results on a number of fillets of the same size and length. This was deemed important, since in many machine parts members may be subjected alternately to tension and compression and to vibratory stresses.

Gen. Jadwin Reports on Flood Protection System For Mississippi River

Long Awaited Official Report of Chief of Engineers Recommends Higher Levees, Bypasses, and a Spillway Above New Orleans at Cost of $296,000,000—Mississippi River Commission to Be Made Subordinate to Chief of Engineers

FLOOD protection works costing $296,400,000 for the Mississippi Valley are recommended in the long awaited report of Major-Gen. Edgar Jadwin, Chief of Engineers, U. S. Army, just transmitted to Congress by the President with his endorsement. The recommendations represent a thoroughgoing revision of the present Mississippi River Commission's project as well as of the system under which work has been carried on heretofore. Depending on levees only is for the first time abandoned, and declared to be incapable of providing for the maximum predicted flood. The essentials recommended are:

The Project in Outline

(1) The present levee system is retained as the basis of the new project, but the levees are to be raised somewhat and at some points are to be set back. To prevent failure from causes other than overtapping and bank caving the levee section is to be enlarged. The maximum section, generally, will be, river slope 1 on 4, crown 12 ft. wide, and landside slope about 1 on 6;

(2) Three large overflow channels or floodways outside the levee lines are to be provided, all on the west side of the river, located as shown on the map, Fig. 3;

(3) Just above New Orleans a controlled spillway into Lake Pontchartrain is to be built;

(4) Backwater ponding in the lower ends of the principal flood basins is utilized for further relief, these backwater areas being submerged only in occasional floods, from once in three years to once in fifteen years;

(5) Bank revetment on a large scale (to cost $115,000,000) is provided for channel stabilization;

(6) A complete topographic map of the valley is to be prepared as a preliminary, and the estimates included a figure of $1,000,000 for this work.

As to the administrative system which should be set up for carrying out this great project, General Jadwin recommends that the local authorities be required to meet part of the construction cost—$37,440,000 out of the total figure stated above—and in addition all costs of right-of-way and incidental damages, while the United States Government should pay the rest. Direction of the work by the Mississippi River Commission is to be improved by placing the commission under the direction of the Chief of Engineers.

In connection with these specific recommendations, the report discusses various alternative solutions that have been proposed, and finds against them. In particular, it states that reservoirs would not be capable of dealing with the flood problem at any reasonable cost.

No details on the determination of maximum probable flood are given in the report, nor is levee construction discussed except to say that the earth levee is the best type for the purpose. The plans and estimates do not include the tributaries except for a short distance above their mouths; the subject of tributaries is still under study.

At the outset, the report declares that the past plans of the Mississippi River Commission have been proved unsuccessful:

> The plan heretofore pursued has been the construction of levees high enough and strong enough to confine all of the flood waters within the river channels. The levees that have been constructed are not sufficiently high for such floods as are now predicted. . . . Insufficient room was left in the river for the passage of the unprecedented volume of flood water. The levees must be strengthend, but a halt must be called on further material increase in their heights and the consequent threat to the inhabitants of the areas they are built to protect.
>
> Man must not try to restrict the Mississippi River too much in extreme flood. The river will break any plan which does this.
>
> The plan recommended provides the requisite space for the passage of floods, and levees of adequate strength to withstand them.

Features of the Plan

The report deals only with the delta region, that portion of the river south of Cape Girardeau.

Reconstruction of Levees—A slight increase of levee height, setting back of levees, and strengthening of the standard section, are contemplated quite generally.

The extreme northern stretch, from Cape Girardeau to Cairo, is to be protected solely by levees, requiring a slight increase in their height. From Cairo to New Madrid the levees will not be raised, but a riverbank floodway is to take the peak flow. From New Madrid south to the mouth of the Arkansas the levees will be raised about 3½ ft., and local setbacks will be made below Helena and other bottle necks to increase the cross-section. From the Arkansas to the Red, where a large floodway west of the river is to be built, the levees will be raised about 3 ft., and the levees on the south side of the Arkansas will be strengthened and raised about 3 ft. to prevent flood waters from entering the Tensas basin. Below the Red River a few setbacks will be made, but levees will be raised only 3 ft. or less. No increase in levee height is contemplated at New Orleans, as it would be both unsafe and too costly. The levees on the south bank of the Red River are to be strengthened and raised to confine flood waters to the Atchafalaya floodway. Existing levees on the Atchafalaya will be strengthened and their grade adjusted so as to keep all floods less than 1927 magnitude out of the floodway back of these levees.

Floodways—From Cairo to New Madrid, in the northern section of the flood region, no increase of flood plane is allowable because of the situation of Cairo, which is in a highly exposed position and whose protecting levees are not susceptible of safe raising. As the west bank levee between Cairo and New Madrid "chokes the river unduly," a new levee is to be built, set back 5 miles, to lower the flood plane at Cairo 6 ft. (which will keep the extreme predicted flood safely below the Cairo levees). The existing river-bank levee is to be retained, but lowered 5 ft., so that it will protect the land back of it in floods up to the 1922 size while allowing the space be-

tween new and old levees to act as floodway in all greater floods.

Levee improvements below New Madrid and south to the Arkansas River will enable the main river itself to carry the highest predicted flood. A floodway alongside Crawley's Ridge would be too costly ($220,000,000), and safe levee raising is practicable.

The second floodway is contemplated west of the river below the Arkansas, since the river cross-section between the Arkansas and the Red Rivers cannot be made to carry extreme floods without dangerous increase in levee height. The floodway is provided along the Boeuf River, and is bounded by stretches of high ground and intervening new levees. This floodway will be dry in all floods up to a size between the 1922 and 1927 floods, but at still higher stages the levees at its upper end, at Cypress Creek, will blow out, being kept at present levee grade for this purpose, and the floodway then will carry a large volume of water down to the backwater area at the mouth of the Red River.

Below the mouth of the Red, the main Mississippi levees also are unable to carry the flow of extreme floods, so that "at high floods it is also necessary to divert down the Atchafalaya basin the flood waters in excess of the discharge capacity between the levees of the Mississippi."

For this purpose, a wide floodway is formed along the course of the Atchafalaya River, bounded by back levees. The existing Atchafalaya levees are to be retained, however, so that up to the 1927 flood stage, the diversion flow will be kept in the channel of the Atchafalaya, going out into the wider part of the floodway only in case of still greater floods. Here, also, the head of the floodway will be closed by what General Jadwin calls "safety plug" or "fuse plug" levees, whose height is so adjusted that they will be topped at the 1927 level and will then blow out.

The necessary auxiliary raising and strengthening of nearby stretches of levee along both the Red and the Mississippi in order to carry the flow until the fuse plug levees break, are included in the project. The two sills in the Atchafalaya River at Simmesport may be removed. The report says nothing of control works to limit the Atchafalaya diversion flow. Diversion of the Atchafalaya across Teche Ridge to Vermillion Bay, in order to relieve Morgan City, was considered but rejected.

Bonnet Carré Spillway—Since the levees at New Orleans cannot be raised, on the score of both structural safety and cost, protection to New Orleans with its half million population is to be assured by a special floodway a short distance upstream of the city.

The most practicable location is on the east side of the river, discharging into Lake Pontchartrain. A controlled spillway at Bonnet Carré will limit the discharge through this floodway to that necessary for the protection of the city. . . . The spillway is so designed as to afford control of the discharge into Lake Pontchartrain. This discharge will be begun when the flood stage at New Orleans has reached 20 on the Carrollton gage; it will be regulated to prevent the stage rising above 20, and will be cut off as soon as the stage has fallen below that figure.

The spillway is to have a discharging capacity of 250,000 sec.-ft., and as the maximum flow in the main river just above this in the extreme possible flood is calculated as 1,500,000 sec.-ft. (after deducting the flow down the Atchafalaya), only 1,250,000 sec.-ft. maximum will pass New Orleans. This is expected to eliminate scour along the New Orleans waterfront, which at present is reported to be serious in high floods.

The spillway is expected to operate only about once in five years, for a period of one to three months. The silt carried by the discharge will be deposited mainly in the upper end of Lake Pontchartrain, but will not exceed ¼ in. of depth per year if all of it deposits within 10 mi. of the floodway outlet. The design of the spillway is to be such as "to prevent even the remote possibility that the discharge will cut a channel from the river into Lake Pontchartrain."

Safety-Valve Levees—After consideration of safety-valve spillways over the levees to discharge excess flows into the basin lands, it was decided that for the present the fuse-plug levees at the heads of the two floodways described would give the necessary control and safety for the two lower sections of the river, while for the upper section the present levees can be made safe against any predicted flood and safety valves are not now necessary. If the future should indicate that floods may come larger than those now predicted, safety valves can be added.

Maximum Possible Flood

The report states that the plan is designed to protect against the greatest flood predicted as possible.

The flood used in the design of this plan is that predicted by the Weather Bureau as the *maximum possible* and by the Mississippi River Commission as the *maximum probable*. The stages predicted by these two bodies were practically the same. When there was a difference, the higher stage was used. This resulted in a projected flood with stages, if confined, of 66 ft. at Cairo. The Weather Bureau obtained its maximum possible flood at Cairo by using the maximum Ohio flood with "the Mississippi, Cumberland, and Tennessee Rivers contributing their tithes at just the proper time to insure the greatest effect at Cairo, an improbable occurence it is admitted but nevertheless a remotely possible one." The predicted stage at Arkansas City, 74 ft., is the result of the above stage at Cairo and the Arkansas and White at their maximum predicted stage. Below the Red, the same flood reduced by river channel reservoir capacity and with flow from the Yazoo and Red added gives the project flood, which is taken at 3,000,000 sec.ft. . . . Were it attempted to hold the water within the present levee lines by raising them, river stages are possible as much as 6 ft. above the present levee grade at Cairo, 14 ft. above the present levee grade at Arkansas City, and from 10 to 13 ft. above levee grade below Red River.

With the "maximum possible" flood as defined in the above, the recommended control plan, the report says, is designed so that the levee grades proposed are slightly above the greatest predicted flood. The improbability or infrequency of occurrence of a superflood such as is predicted as the maximum justifies a very slight factor of safety for it. Strengthened and widened levees will permit such a flood to be fought successfully. The grades have a *normal factor of safety* for a flood of the size of that of 1927.

The "normal factor of safety" is apparently represented by a freeboard of 5 ft., which is 2 ft. greater than that hitherto adopted by the Mississippi River Commission.

Other Flood-Control Schemes

Some of the plans that have been suggested for controlling the Mississippi floods are characterized as visionary.

Even the richest country in the world cannot afford to dig channels ten times as large as the Panama Canal halfway across the continent through mountain ranges, nor pump through pipe lines over 100,000,000 tons of water per hour from Cairo, Ill., to the Gulf of Mexico.

Other proposed solutions of the problem were rejected either on the basis of their obvious defects or after

a study of their possibilities and costs had shown them to be of doubtful value.

Dredging the River Annually—If flood heights were to be reduced by dredging the river each year, an annual expenditure of $10,000,000 would be required for the first foot of reduction, and therefore more than $80,000,000 for reducing the stage by 8 ft., the amount required for safety. This represents a capitalized cost (at 4 per cent) of $2,000,000,000, and even so the result would be problematical.

Side Channels—The cost and doubtful effectiveness of excavated side channels makes them impracticable. A 300,000-sec.-ft. channel from Cape Girardeau to the White River would cost $337,000,000, or twelve times as much as providing the same capacity in the main river.

Widening the River—Moving the levees on one side of the river 6 miles back would increase the discharge of the main channel about 500,000 sec.-ft., decrease stages 8 ft., and cost $1,000,000,000. It would destroy many towns and remove all settlements too far from the low-water channel to be served by navigation. It would also relegate to the river the most valuable part of the valley, namely, the high bank, and the new levees would be on lower ground and therefore more costly and dangerous. General setting back of the levees is therefore held to be neither practicable nor economical. Local setbacks are included in the recommended project, as already noted.

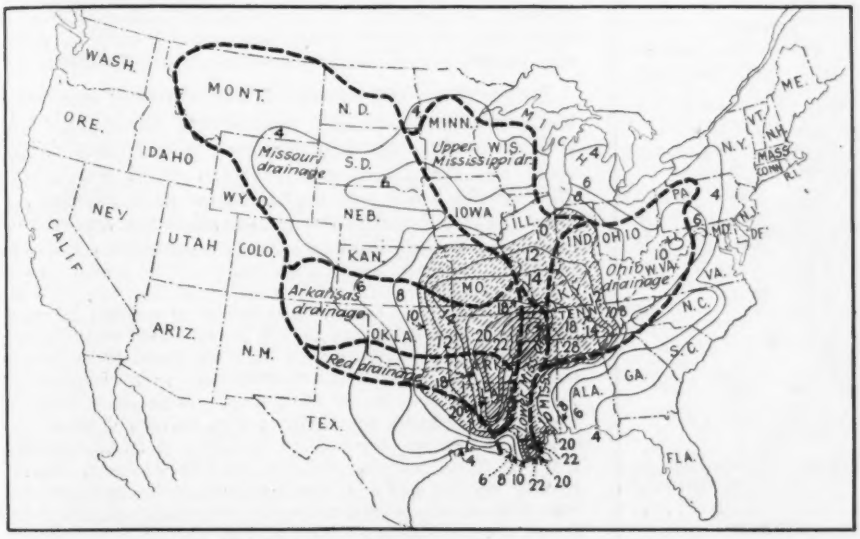


FIG. 1—RAINFALL DISTRIBUTION IN 1927 FLOOD

Straightening Channel—On river straightening, the report says:

> Artificial or natural cutoffs shorten the reach where they occur and by increasing the slope and velocity produce a local lowering of the flood stage. However, the increased velocities immediately cause excess bank caving. . . . The method is too uncertain and threatening to warrent adoption. . . . The river banks are not yet revetted to the extent necessary for shortening of the stream, nor will they be for years; levees are already in place, though not to final height, conforming to the river in its present shape; the value of all cultivated land would be lost, and landings at towns along the river would be cut off from navigation. . . . It is advisable to adhere to the present policy of preserving the river generally in its present form.

Forestation—Attempts to reduce floods by increase of forest area are declared to be ineffective, and Col. W. B. Greeley, chief forester, is quoted as saying that "Forests hold back flood discharges, but they cannot prevent large floods when heavy rains occur." General Jadwin continues:

> A flood of the Mississippi is not the torrential rush of water from denuded hillsides, but is the slowly rising, long continued outpour of the drainage from a vast region. Studies of the reservoir board have shown that, to reduce the flood stage of the Mississippi by 1 ft., it is necessary to store from 7,000,000 to 11,000,000 acre-ft. of water. The absorption and retention of ½ in. of rainfall on the 8,000,000 acres of land covered in the recommendation of the forestry report would therefore reduce flood stages by but ½ in. . . . While, therefore, reforestation, like reservoir construction for local purposes, is a step in the right direction and will be beneficial in reducing erosion, it cannot be considered as a measure warranting inclusion in a comprehensive flood control project for the alluvial valley of the Mississippi.

Reservoirs—Reservoir detention of the flood waters was studied by a reservoir board which examined all available reservoir sites. The conclusions are indicated in the following:

> It has been found that by constructing 203 headwater reservoirs at a cost of about $1,300,000,000 and by operating these reservoirs primarily for Mississippi River control, it would be possible to produce a dependable reduction in stage of about 6 ft. at Cairo, 7 ft. at the mouth of the Arkansas River, and 5.4 ft. at the mouth of the Red River. The value of local benefits from these reservoirs is placed at about $150,000,000, leaving a net cost of $1,150,000,000 chargeable to the control of the floods in the alluvial valley. . . . These reservoirs would afford inadequate relief at a cost four times as great as the cost of the plant for complete protection proposed herein, which includes navigation and bank protection.
>
> . . . Reservoirs near the valley can be operated more effectively than headwater reservoirs. A system of 30 reservoirs not more than 5 days' flow from the Mississippi River was studied. These 30 reservoirs would cost about $525,000,000 after credit for local benefits. They would produce a dependable reduction in stage of about 3 ft. at Cairo, 10 ft. at Arkansas City, and 7 ft. at Vicksburg. . . . They will not completely solve the flood problem, and will be much more expensive than the complete project recommended.
>
> The reservoirs in the above plan above Cairo are more expensive and less effective than those on the White and Arkansas Rivers. If the former be omitted, there would remain 11 reservoirs on the Arkansas and White with a capacity of about 37,000,000 acre-ft. at an estimated cost of $240,000,000. In the 1927 flood these reservoirs would have reduced the stage about 8 ft. at Arkansas City and 5.4 ft. at the mouth of the Red River. They would have considerable value for local flood protection in the lower valleys of the Arkansas and White Rivers. They would reduce the maximum flow through the proposed Boeuf River flood channel about 50 per cent and would make unnecessary the proposed flood channel east of the Atchafalaya. They would also reclaim considerable back-water areas at the mouths of the Arkansas and Red Rivers. A calculation indicates that the value of the backwater areas reclaimed by these reservoirs would not be increased by more than $25,000,000.

Under the recommended plan, the area that would be reclaimed can be used four-fifths of the time. The value of all these benefits would be less than $75,000,000. The addition of these reservoirs, therefore, would materially increase the cost of the proposed complete project. They are therefore not advisable at present.

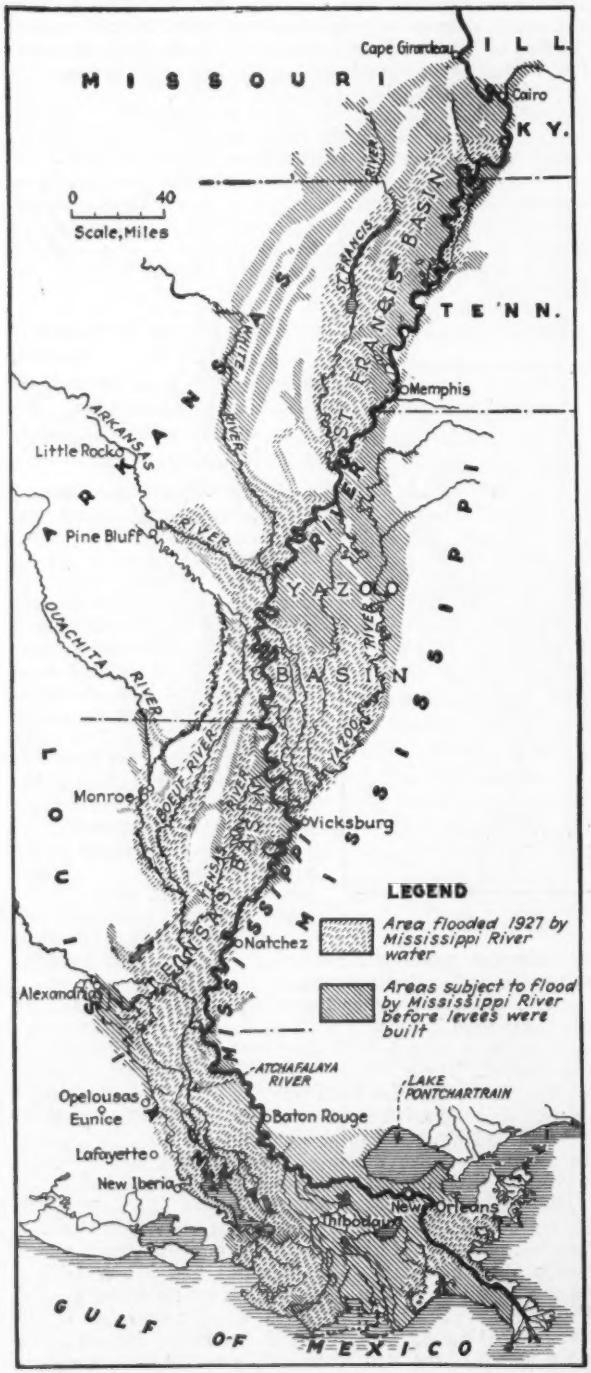


FIG. 2—MISSISSIPPI RIVER FLOOD BASINS AND AREA FLOODED IN 1927

St. Francis Basin Storage—Converting the entire St. Francis basin into a series of reservoirs by transverse levees would reduce river stages below Memphis about 6 ft., at an estimated cost of $746,000,000. It would leave the stage still 8 ft. above present levee top at Arkansas City and therefore would not completely solve the problem. Because of this and its cost, the project is not considered advisable. The lower basins would cost about as much and would have the further disadvantage of not protecting the land above them. Moreover, the potential value of the land in the St. Francis basin is increasing.

In general, it is estimated that 7,000,000 acre-ft. in valley storage and 11,000,000 acre-ft. in headwater storage would be required to reduce gage heights 1 ft. at Arkansas City.

Such aid as may be hoped for from reservoirs can be secured economically only by gradual processes. As time goes on, it is hoped that reservoirs constructed primarily for local purposes will withhold flood waters and thus aid Mississippi control by affording an additional factor of safety. . . . In most cases the benefits for power or local flood protection are of greater value than benefits resulting from the use of the reservoirs for flood control on the Mississippi. The people of the states where they would be constructed will probably claim a priority in the benefits over the lower states. Such reservoirs as are built would therefore probably be used primarily for benefits on the tributaries, and in that case their effect on lower Mississippi floods would be much smaller than it would be if used exclusively for the latter.

Levees Only—Discussing various phases of levee control, the report first says that several thousand cross-sections of the river measured from time to time fail to show any material change in the channel dimensions. Neither the levees nor the crevasses have affected the river channel capacity. Whatever scour has occurred to deepen or enlarge the channel has been balanced by filling. Accordingly, the report says:

Since levees only cannot be relied on to produce by scour a channel sufficiently large to care for all floods, such channel can be obtained only by setting back the levees or by raising them. Setting back is shown elsewhere to be impractical. To raise the levees on the Mississippi sufficiently to hold the maximum predicted flood with a 5-ft. freeboard would require that they be raised 12 ft. at Cairo, 19 ft. at Arkansas City, 12 ft. at Angola, and 6 ft. at New Orleans. An increased section and 5-ft. freeboard would be necessary for such high levees. Such a raising is most inadvisable since the levees are now about as high as they should be. Levees of such heights would increase tremendously the hazard from possible crevasses and would involve many foundation difficulties. It is doubtful if such a raising would be practicable. The cost would be $566,500,000.

Channel Stabilization

An extensive program of channel improvement to hold the banks of the river is considered to be a necessary part of the project. The report says:

Since the levees within the limits of this project are to be greatly enlarged, they will be much more expensive than heretofore, so something must be done to avoid the frequent moving of them from the proximity of caving banks. In addition, the river cannot be regulated for low-water navigation until the banks are made stable, this both to keep the channel in one place and to stop the enormous dumping of earth into the river by bank caving. A general bank protection scheme must be carried out. This will consist of revetting banks by proven methods and, in addition, trying new and cheaper methods to accomplish the same result. At the same time, regulation of the kind which has been successfully accomplished above Cairo will be undertaken below, when and where the banks become stable. The plan includes a 10-year program of channel stabilization and river regulation, at a total cost of $110,000,000, or $11,000,000 per year. This program may need revision upward after some years, as the rate and total amount of work above contemplated is a minimum.

Tables I and II herewith give the areas of land affected and the estimated costs of the several items of the plan. From Table I it will be seen that about two-thirds the area of the whole alluvial valley will be protected every year.

Table II shows figures of about $140,000,000 for levees on the main river, $38,000,000 for the three west side floodways, and $8,000,000 for the Bonnet Carré spillway; the previously mentioned item of $110,000,000 for channel stabilization; and an item of $1,000,000 for mapping, a total of $296,400,000.

TABLE I—PROTECTED AND FLOODED LAND AREAS IN MISSISSIPPI VALLEY

Area in alluvial valley subject to overflow by Mississippi River water if there were no protecting works, approximately		30,000 sq.mi.
Approximate conditions after recommended plan is completed		
Protected all the time		20,500 sq.mi.
	Cleared Land	Swamp and Timber Land*
Protected on an average of 14 years in 15	215 sq.mi.	960 sq.mi.
Protected on an average of 11 years in 12	950 sq.mi.	1,300 sq.mi.
Protected on an average of 9 years in 10	135 sq.mi.	90 sq.mi.
Protected on an average of 4 years in 5	1,540 sq.mi.	3,260 sq.mi.
Protected on an average of 2 years in 3	500 sq.mi.	500 sq.mil
Total	3,340 sq.mi.	6,110 sq.mi.

*Swamp and timber land serves for the growth of trees just as well wet as if dry.

As to whether the Federal Government or the states shall pay the cost of the work, the report says:

The suggestion is made that a distribution by which the cost of flood control work in general is borne 80 per cent by the Federal Government and 20 per cent by the valley states, and the entire cost of channel stabilization is borne by the United States, would accord with the fiscal policy of the President and the precedents established by Congress.

The local authorities also are to provide rights-of-way, and pay for any damages and for the cost of incidental drainage works, which items are not included in the total cost estimated.

With this plan, except for backwater storage areas, complete protection is given to the St. Francis basin; to the Yazoo basin; to the Tensas basin, except the floodway; to New Orleans and the country east of the main river except Bonnet Carré floodway, and to all the country west of the Mississippi except the Atchafalaya floodway.

TABLE II—ESTIMATED COSTS OF MISSISSIPPI RIVER FLOOD CONTROL UNDER JADWIN PLAN

Cost of Land, Incidental Damages and Some Minor Works Is Not Included

Below Red River:	
Bonnet Carré Spillway	$8,200,000
Mississippi levees	16,700,000
Floodway east of Atchafalaya	12,600,000
Floodway west of Atchafalaya	17,300,000
Red to Arkansas:	
Mississippi levees	59,300,000
Boeuf Basin floodway	7,700,000
Arkansas to Cape Girardeau:	
Mississippi levees	53,900,000
Auxiliary levees	7,700,000
Channel stabilization	110,000,000
Mapping	1,000,000
Total	$296,400,000

Topographic Mapping — No complete topographic maps of the alluvial valley of the Mississippi exist at present, says the report. It recommends that such maps be prepared by "existing agencies of the government now organized for mapping work," and includes a figure of $1,000,000 in its estimate for the cost of these maps.

Execution of Plan—The report states that the project should be completed in 10 years, with an expenditure of $25,000,000 in the first year and about $30,000,000 in each of the following years.

It is recommended that the responsibility for the execution of the plan, the details of the design, and location of the engineering works and structures be placed upon the Chief of Engineers under the supervision of the Secretary of War, as is done by acts of Congress in the case of river and harbor improvements.

This recommendation is contrary to the system of controlling the work along the river through the Mississippi River Commission, set up by Congress in 1879, and for

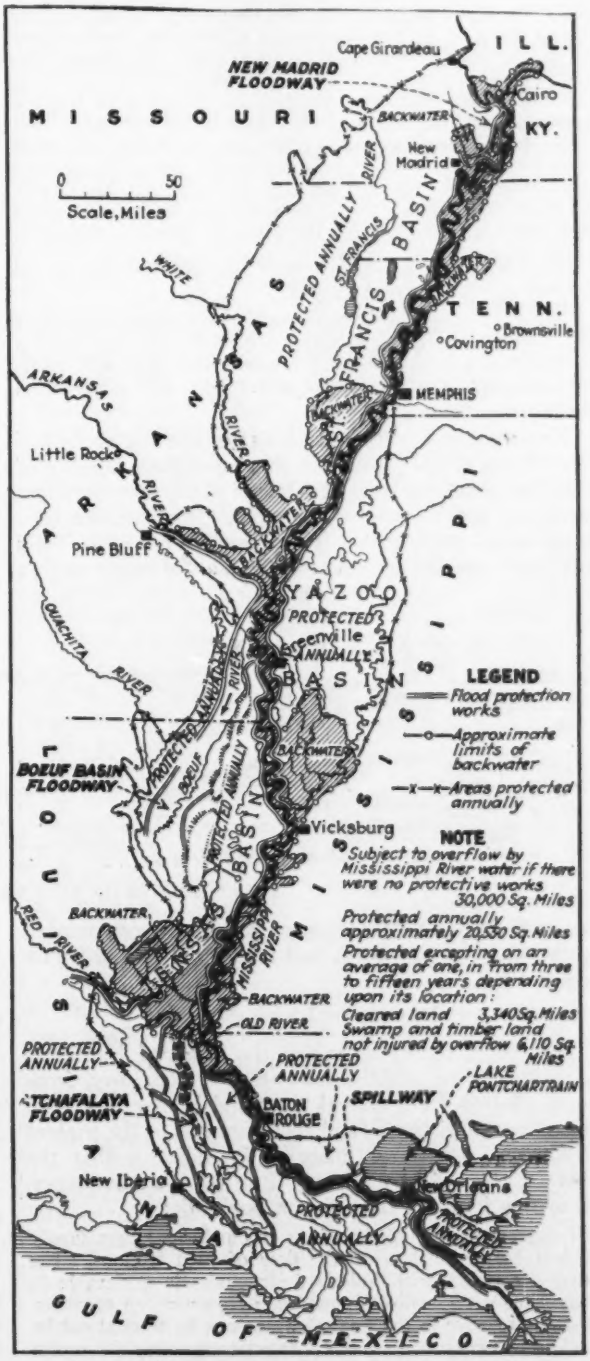


FIG. 3—MAIN FEATURES OF PROPOSED FLOOD PROTECTION SYSTEM

Hatched areas indicate submergence from backwater at lower ends of flood basins in occasional years; dash line shows boundary of protected area. Note river bank flood channel from Cairo to New Madrid, wide floodway west of the river in the Tensas basin, and Atchafalaya floodway. Just above New Orleans a spillway into Lake Pontchartrain is also proposed.

this reason is further discussed and amplified in the following paragraph of the report:

The Mississippi River Commission has done able work and accomplished excellent results since its formation. However, work can be done more efficiently with unit control than with divided control. At present, the Chief of Engineers and Secretary of War have veto power over the Mississippi River Commission, but not initiative control. It is recommended that under the direction of the Secretary of War, the Chief of Engineers be given authority to plan and direct the work on the Mississippi River, with the president of the commission reporting direct to him. The commission as at present constituted can be continued as an advisory, but not as an executive commission. Because of the importance and magnitude of the duties under his charge, the president of the commission, while actually assigned to such duty by competent orders, should receive the rank, pay and allowances of a brigadier general of engineers. He should, to be eligible for such assignment, have the qualifications now prescribed by law for the assistant chief of engineers.

Maintenance: Legislation — On the importance of maintenance, the report says:

The warning cannot be too strongly emphasized that unless the flood discharge capacity provided in the plan herein recommended is preserved, a future great flood will result in a disaster as great as or greater than that experienced this year.

Accordingly, it recommends the enactment of federal laws which would protect the flood discharge capacity of the alluvial valley of the Mississippi in the same way that navigable waters are now protected. In particular, such laws should provide that it shall not be lawful to build any levee or other structure in the alluvial valley or in a floodway therein unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War.

HYDRAULIC LABORATORY

The report recommends that the Chief of Engineers be authorized to establish an hydraulic laboratory, from funds allotted from annual river and harbor and flood control appropriations (and therefore not in the present Mississippi Control estimate). It indicates that the laboratory would be used only little for the Mississippi, but mainly for other river and harbor work:

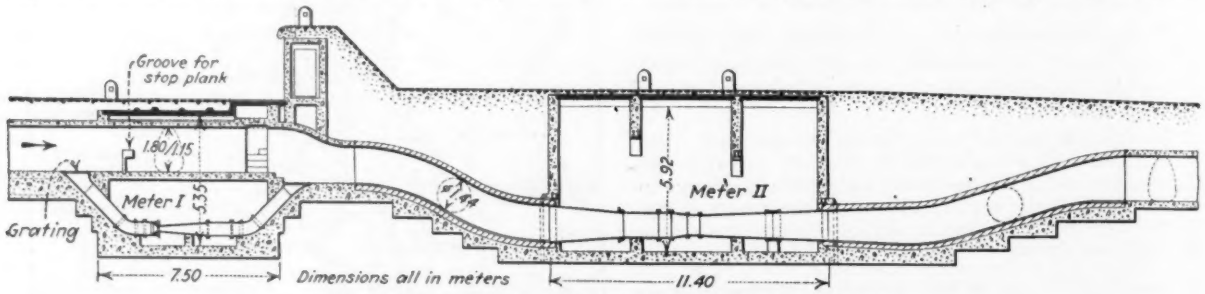
Measurements and observations on our large rivers supply the best hydraulic data on the flow of such streams, since actual experience with full-sized structures is preferable to experiment with small-scale models. However, on occasion, questions relative to the flow of water can be worked out by small-scale experiments. Such experiments may be useful in some of our lock and dam design. In addition, the organization in charge of an hydraulic laboratory may well be charged with the co-ordination of field data relative to the flow of the Mississippi and other rivers. For instance, it could advantageously take charge of discharge measurements, silt measurements, slope and velocity measurements, etc., and make studies and draw conclusions therefrom. It could be a clearing house for such engineering data and publish the same.

Special Board—A number of special boards carried on extended studies for the purpose of this report. They included a board on diversion channels, headed by Col. E. H. Schulz; a board on navigation, headed by Major Stuart C. Godfrey; a reservoir board, headed by Col. William Kelly; and a spillway board, headed by Col. William T. Wooten. These and the Mississippi River Commission, headed by Col. Charles L. Potter, brought together and analyzed a large part of the data embodied in the report.

Two Venturi Meters in Series With Range of 1:100

Two Venturi Meters in Series With Range of 1:100 on Water Supply Conduit of Munich, Bavaria

ORDINARILY the standard venturi water meter has a range of capacity of not over about 1 to 12; which, however, suffices for situations as they are commonly met with. Occasionally the quantity to be metered ranges from 1 to more than 12, in which cases it has been customary to employ two meters, a large one and a small one, placed side by side. A much neater arrangement (see illustration) is that designed by Chief Engineer Henle of Munich, Bavaria, and built for the spring-water supply Thalheim-Muehlthal, which has a range of 1:100. Mr. Henle's explanation of its working is as follows:



ARRANGEMENT OF TWO VENTURI METERS IN SERIES

"Meter I gauges correctly from 18.5 to 185 l. per sec., Meter II from 185 to 1,850 l. per sec. So long as the quantity to be metered remains under 185 l./second it will pass through the grating into Meter I, which will correctly gauge it; and will then flow through Meter II, though without exact registration. By the time the quantity flowing in the masonry conduit has increased to 200 l./second a part of the total will pass Meter I, while the balance will pass over the grating and along the masonry conduit; but both of the partial quantities named must pass Meter II, and will by it be correctly measured; the indications of Meter I being at the same time disregarded. "A groove in the masonry permits the insertion of a little stop-plank, of a height (determined by experiment) that will insure the passing of all of 185 l./second, into Meter I.

"The arrangement of a small and a large meter in series, to increase the range of the metering station, has the advantage of acting automatically, during an increase of the quantity to be metered beyond the range capacity of the smaller meter; the more so if the registering apparatus is constructed to register only for that of the two meters which is at the time correctly metering."

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Quarter Centenary of This Section

The twenty-fifth anniversary of this section, established as the Engineering Literature Supplement to *Engineering News*, is marked by the present issue. The section has a double function, news and criticism. The criticism also has a double function: aid in the selection of books for private, professional, business, college and public libraries and the promotion of higher standards for engineering literature. To these ends, the specialists on the editorial staff have always been liberally supplemented by the services of outside reviewers. This and the other policies outlined will be continued in this section of *Engineering News-Record*.

A Valuable Contribution to Hydrology

REVIEWED BY H. K. BARROWS
Professor of Hydraulic Engineering, Massachusetts Institute of Technology, and Consulting Engineer, Boston

HYDROLOGY OF THE GREAT LAKES—By Robert E. Horton in Collaboration with C. E. Grunsky. Report of the Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and a Program of Remedial Measures. Part III, Appendix II. Chicago: The Sanitary District of Chicago, 6 North Michigan Ave. Paper; 6 x 9 in.; pp. 432; tables, maps and diagrams.

As a part of the work of the Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and a Program of Remedial Measures in 1924-5 studies were made of rainfall and evaporation in the Great Lakes region and of lake levels and outflow. While providing sufficiently reliable data for immediate use, time did not permit the compilation or correlation of final results. This has since been done by two eminent authorities in the field of hydraulic engineering. This unusually complete discussion of the hydrology of a region world-famous for its water resources, will attract wide attention.

The Great Lakes are remarkable for size and for the extent of water surface relative to total drainage area and for the resulting exceptional capacities for water storage. The lake system drains about 288,000 sq.mi. of which 60 per cent is in the United States and averages 33 per cent of water area, of which 53 per cent is in this country.

The hydrology of this lake region is attracting especial attention at this time because of the increasing importance of navigation and the agitation for the St. Lawrence waterway, as well as the present low stages of the lakes, the question of the effect of diversions from them and the obvious need of lake level regulation.

Col. Kearney of the U. S. Engineers measured the outflow of the three upper lakes in 1856. Henry made more extensive measurements of flow in 1865-69 and also of evaporation at stations adjacent to the lakes. Since 1896 numerous and reliable gagings of the flow from the different lakes have been made by the U. S. Lake Survey. Records of lake levels extend back to 1860 or earlier, while adequate rainfall data are available for both this country and Canada. Data of runoff of tributary streams are less satisfactory and do not antedate 1900.

In Chapter III is an interesting study of the effect of deforestation and changes in agricultural conditions (which have occurred to a marked extent since 1860) upon rainfall and run-off. These changes have included both the cutting off of the primeval forests in Northern Michigan (and in a large measure the hardwood forests also) and an increase in the extent of land under cultivation over the whole state.

The nature and amount of water losses—interception, transpiration and soil evaporation—are clearly presented, with such data as are available for estimates of these facts, including original measurements made at Mr. Horton's field laboratory. The studies show that average water losses for the northern pine region of Michigan are now about 15 in. yearly, as compared with 20.5 in. when forested. The southern region, due to more intensive cultivation, shows slightly greater water losses under present conditions than with the hardwood forests. For the state as a whole it appears certain that the effect of deforestation and all cultural changes has been a gradual decrease in water losses up to about 1900, with some reversion since toward original conditions. So far as the effect of reduced water losses is concerned, therefore, deforestation of the drainage areas of Lakes Michigan-Huron has tended to prevent these lakes from falling as low as they otherwise would have fallen. But the great increase in land area devoted to corn and small grains in the drainage areas of Lakes Erie and Ontario has caused progressively increasing water losses and a reduction of runoff for these lakes.

Changes in lake outlet conditions (Chap. IV) have been important as effecting lake levels. Beginning at Niagara River, the elevation of Lake Erie is controlled by outflow from Lakes Michigan-Huron, by shoals at the head of Niagara River, and to a less extent by the crest of the rapids at Niagara Falls. The backwater effect of Lake Erie reacts through the Detroit River into Lake St. Clair, whose level with the channel topography of the St. Clair River controls the level of Lake Huron. Changes in channel control of Niagara River for navigation improvement, combined with diversions from this river, have operated to increase the discharge capacity somewhat from Lake Erie. Marked changes in the St. Clair and Detroit Rivers and in Lake St. Clair have been made, however, mostly for navigation purposes, with the result that the increased outlet capacity of Lakes Michigan-Huron has drained these lakes into Lake Erie to such an extent (probably at least 8 in.) as to offset in part the effects of other causes operating to lower Lake Erie levels.

Lake Superior has been regulated by works constructed in 1911 and since that time has been kept within about 1 ft. of the mean level for the period 1860-1884, in spite of the deficiency of rainfall in recent years. While this regulation of Lake Superior has, by holding back water, contributed to the lowering of the level of Lakes Michigan-Huron, the author points out that had suitable regulating works been in operation on St. Clair River the levels of Lakes Michigan-Huron could also have been

maintained much higher than they are at present, in spite of the reduced water yield of their basins, and the reduced outflow from Lake Superior.

The most important permanent diversion from the lakes (Chap. IV) is that by the Sanitary District of Chicago, which diverted in 1924 an average of 9,465 sec.-ft. through the Chicago drainage canal into Illinois River and thence to the Mississippi. The level of Lake Erie is also affected somewhat by flow through the Welland Canal and water used for power development at Niagara. The total effect of all diversions, as given in the report of Col. J. G. Warren in 1921, has been to lower Lakes Michigan-Huron about 5½ in. and Lake Erie 9 inches.

Rainfall data (Chap. V and VI) are relatively numerous and complete—utilizing data at 47 stations in the United States and 7 in Canada for the period 1871-1923. For this 53-yr. period the annual rainfall was about 28 in. on the Lake Superior basin and about 34 in. on each of the other lakes. For the whole lake system it was 32 in. with a range of from 87 to 119 per cent of the normal. An additive correction varying from 4 to 6 per cent of the winter precipitation was applied to recorded values at ordinary stations to allow for deficiency in the rain-gage can method of snowfall measurement based upon a formula derived by Horton for eastern New York. While the author questions to some extent the applicability of this formula, he states that the results are, if anything, still too low. In any event, original and corrected data are given.

It was found that rainfall on the lake surfaces (Chap. VII), particularly on Lake Michigan, is less than that measured at shore stations. This difference, occurring especially in the summer time, is probably due chiefly to diminished thunder storm frequency and intensity over the lakes. The correction factor for lake rainfall was obtained from a comparison of rainfall at certain island stations with adjacent shore stations. For Lake Michigan this factor was 0.93 for winter and 0.94 for summer; for Lake Erie, 0.84 for winter and 0.85 for summer.

Lake surface temperatures (Chap. VIII) necessary as a basis for determination of evaporation, were available from U. S. Weather Bureau records for the period 1874-1886. From these records a table of mean departure of water from air temperature was constructed and used for the period after 1886, in connection with the U. S. Weather Bureau air temperatures, to estimate water temperatures, where not directly available.

Evaporation (Chap. IX) is an especially interesting chapter, with a clear presentation of the subject of evaporation from water areas. A formula developed by Horton in 1917 (*Eng. News-Record*, Apr. 26, 1927, p. 196) is used for detailed computation of evaporation for each lake (omitting Lake Ontario). This formula is a modified form of the well known Dalton formula, but adapted to take into account the effect of the vapor blanket overlying the water surface on a large reservoir or lake. It is as follows:

$$E = 73.2\,[\psi V_w - V_b], \text{ where}$$

V_w = maximum vapor pressure at water surface temperature.

V_b = maximum vapor pressure within the vapor blanket and immediately over the water surface.

ψ = a wind factor depending on the wind velocity close to the water surface, and obtained from the formula, $\psi = 2 - e^{-0.3w_0}$, where w_0 is the wind velocity reduced to ground or water surface level.

V_b is the maximum vapor pressure corresponding to Θ_b, the estimated air temperature within the vapor blanket and $\Theta_b = \Theta_w + (\psi - 1)\,\Delta$, where Θ_w is water surface temperature and Δ the difference between air and water surface temperatures.

This method of procedure is novel in the estimation of evaporation, but appears to be based upon sound theory. Valuable data of evaporation on the margins of the Great Lakes by Henry, and the complete record for Rochester, N. Y. (1891 to 1924) are also included in this chapter. In supplement I is also a study of evaporation from the Great Lakes by Grunsky, based upon the Kingsburg evaporation curve. (*Trans.* Am. Soc. C. E. Vol. LXXX, p. 1978.) A comparison of these estimates from various sources is given in the accompanying table. The comparatively wide range in results indicates the need of more research in this field of hydrology.

YEARLY EVAPORATION FROM GREAT LAKES IN INCHES

Lake	Henry Experiments 1868	Henry Experiments 1869	Richmond (Warren Report)	Grunsky	Horton (50-Year Mean)	By Water Yield* (1902-23)
Superior	15.91	12.04	18.67	14.6	15.76	
Mich.-Huron	23.43	17.88	26.08	21.1	29.53	27.22
Erie-St. Clair	24.53	18.61	34.97	26.6	29.24	38.97

* Based upon measured outflow, inflow and rainfall as observed.

Runoff of land surface (Chap. X, as well as Supplements II and VII) includes a discussion of flow data upon streams entering the lakes, which permits of estimation of this factor for the period 1903-24 from land area tributary to Lakes Michigan-Huron and Erie-St. Clair.

Outflow data (Chap. XI) are presented for Lakes Superior, Michigan-Huron and Erie, based upon gagings in the outlet channels and involving, in the case of the lower lakes, corrections for diversions and ice conditions in winter. The flow is determined by the application of formulas (which are tabulated in detail) giving flow in terms of lake elevations. These flow data are presented by months for the many years they are available and constitute, with the records of monthly lake levels in Supplement VIII, data of much value, with some interesting details of methods used.

Comparing the measured outflow with the water production as determined from land surface inflow, rainfall and evaporation, with storage correction, it was found that for the period 1902-23, for Lakes Michigan-Huron, the measured outflow plus diversions was 187,600 sec.-ft., as compared to 170,100 by the computed water production—a difference of about 9 per cent. This difference might be expected in such estimates and indicates substantial accuracy in the estimation of the inflow, rainfall and evaporation

Lake levels and their fluctuations (Chap. XII) is the culminating and perhaps the most interesting chapter of this report. Complete basic data of water levels for the period 1860-1924 are given for each lake, followed by a detailed discussion of causes of lake level variation.

In January, 1925, Lakes Michigan-Huron were more than 4 ft. below their levels in January, 1885. The Chicago and other diversions have lowered these levels from 6 to 8 in. while they have been lowered by channel improvement 8 to 10 in. more, leaving some 30 in. or more of the present lake level depression still to be accounted for. The studies made indicate that this remaining deficiency in level can be fully accounted for by a lessened rainfall of late years as compared with

the period 1880-84. A progressive decrease in rainfall in the upper lakes region since 1885 was in fact suggested some years ago by Kullmer, who found a material lessening in the number of storm paths in the later years.

Comparing the measured outflow of the three upper lakes for the periods 1880-84 and 1920-23 it was found that the reduced amount of the later years would account for a total lowering of Lakes Michigan-Huron of about 36 in. The greater portion of the present deficiency in lake level is therefore due to low rainfall in recent years.

It is also pointed out that the full effect of rainfall deficiency upon lake levels has not yet occurred, so that some further drop of level may be expected. The author is of the opinion, however, that, based upon a study of the longest existing rainfall records—as at Padua, Italy, and New Bedford, Mass.—there is little evidence of any *permanent* change of rainfall in appreciable amount and that the present cycle of low rainfall will sooner or later come to an end. When a cycle of high rainfall years occurs lake levels will rise, but even then a long period of time must elapse before normal levels are reached. "The only complete and adequate remedy," the report states, "is regulation. This is the only means that will provide stable lake levels for all future time."

The "Hydrology of the Great Lakes" not only presents in a clear and convincing manner the reasons for the present low lake levels, but also represents a distinct and valuable contribution to the literature of hydrology. The report is one which the student of hydrology and the hydraulic engineer will wish to study in detail and it provides a wealth of information and basic data that will be of great general value.

The Broadening Field of Sanitation

MUNICIPAL AND RURAL SANITATION—By Victor M. Ehlers, C.E., Chief Sanitary Engineer, State Health Department of Texas; and Ernest W. Steel, C.E., Professor of Municipal and Sanitary Engineering, Agricultural and Mechanical College of Texas. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 448; 119 halftones and line cuts. $4.

The broadening field of public sanitation is surveyed by the authors of this new book, written primarily from the engineering viewpoint. The co-operation of a state sanitary engineer and a professor of municipal and sanitary engineering is here proven to be a happy one, both as to the selection and presentation of fact and opinion. The book seems to go further towards covering the rural than the municipal portion of its field, but it presents the fundamentals of municipal sanitation in a satisfactory manner and gives abundant references to more extended and more highly technical books. In both portions of its field the book will be of material service to health officers and sanitary inspectors who have not had the benefit of college instruction in public sanitation, as also to many engineers who got their technical education before the colleges gave much attention to sanitation—as indeed many colleges still fail to do—or at best did not go beyond water supply and sewerage.

After a brief chapter on communicable diseases, the authors take up excreta disposal, without and with water carriage; water supplies, both isolated and municipal; refuse collection and disposal; mosquito, fly and rodent control; milk and food sanitation; plumbing, ventilation, light, housing, school sanitation, industrial hygiene, tourists' camps, swimming pools, disinfection, vital statistics and finally, public health administration. Model ordinances for privies, mosquito control and milk sanitation are given in appendixes.

The plan, scope and method of presentation of the book are highly commendable. Unfortunately, the index is scanty; at least it contains no entries under engineer or engineering, although the text mentions sanitary engineers again and again, and, as already said, the point of view is essentially that of the sanitary engineer throughout.

German Cement and Concrete

REVIEWED BY P. H. BATES
Chemist, U. S. Bureau of Standards, Washington, D. C.

DIE DEUTSCHE ZEMENT INDUSTRIE—By Dr. Ing. Riepert assisted by Drs. Quietmeyer, Schott and Haegermann. Cloth; 1099 pp.; 682 illustrations and two folding maps. Charlottenburg, Germany; Zementverlag. 40 reichsmarks in Germany.

The celebration in August of this year of the completion of fifty years of the life of the German Association of Portland Cement Manufacturers led Dr. Riepert and his collaborators to prepare this volume of the records of the development of the cement industry in Germany. But to make a thoroughly rounded-out history they have included also the history of the development of portland cement from lime-puzzuolana mixtures, hydraulic limes, etc., the development of the application of cement in the many mortar and concrete products, and finally the financial and economical developments that resulted in the formation of the present "Zement-Bund" or "cartel."

The volume is divided into three parts. The first of these (396 pp.) is given over more particularly to cement —the development of portland cement, of the industry in Germany, of the specifications and test methods and of our knowledge of what cement is. In this portion Dr. Riepert has had the assistance of his collaborators, Dr. Quietmeyer having prepared the section under the first topic just mentioned, Dr. Schott that under the second and Dr. Haegermann that under the third. This part may not be of so much value to engineers but it should be of interest to any who wish to know something of the historical background of one of the materials which they use so much. Such a feature as the development of portland cement, as handled by Dr. Quietmeyer, is worthy of particular attention. It is presented in a very concise manner and seems to evaluate very properly the work of the many who in course of time contributed to the final evolution of this commodity. It is international in aspect. The other portions of this first part have a more distinctly German aspect, but the story of the evolution of the German specifications has a number of points that would hold the interest of all giving attention to the preparation of standards.

Part II (435 pp.) is devoted to concrete. A small portion (43 pp.) is given over to the design of concrete mixes and the remainder to the application of concrete in structures. This small portion on mixture design may seem to be out of proportion to the rest of the part. But apparently the discussion of the various moduli, ratios, etc., enunciated in this country as panaceas for obtaining good concrete either has not penetrated Germany or has been viewed largely as relating to a technique which has advanced so far in Germany as to make these no longer of interest. The latter would seem to be the case as one views the many illustrations of concrete structures in Germany or central Europe. The slenderness of the sections illustrated indicates an ability to make

and place concrete that must be based upon a technique that would require in our country the development and close adherence to even more of the suggested gradations, proportions, etc., than we now have.

Although the remainder of the second part, on the uses of concrete, might have been improved by more thorough presentation of the designs of the structures, with some figures as to the stresses for which they were designed, still the wealth of illustrations of finished structures cannot but repay the attention which the reader may give to them and their explanatory text. It is true that with the possible exception of a concrete gasholder at Dresden there are no types of structures illustrated which cannot be found in this country, but there is a difference in finished effect which should prove worthy of study by our engineers.

The last part of the book is of no value to construction engineers, but for the financial engineer—if there be such a class—its perusal is likely to result in such a mental condition that possibly the least said about it the better. Briefly, it traces those economical developments within and around Germany that have led finally to certain combinations which under the laws of Germany are not "in restraint of trade." As a result, Germany is now divided into three parts. As a consequence there is a certain type of contentment among the producers, at least, which is not in evidence on this side of the Atlantic Ocean.

The volume makes an excellent appearance. It is decidedly larger than we would attempt in this country. But on the other hand it is typical of the thoroughness with which a German does so many of his tasks. For this very thoroughness it should be valuable to any who want to be more familiar with cement and concrete.

A New Municipal Responsibility

AIRPORTS AND AIRWAYS: Cost, Operation and Maintenance—By Donald Duke, First Lieutenant, Air Corps, U. S. Army; Airplane Pilot; Chief, Airways Section, Army Air Corps; Chairman, Aerial Navigation Chart Committee, Federal Board of Surveys and Maps. [Ronald Aeronautic Library: C. deF. Chandler, Editor.] New York: The Ronald Press Co. Cloth; 6x9 in.; pp. 178; 23 line cuts, 41 halftones. $5.

Writings on aviation increase. So far, most of them, of any appreciable technical value, have considered such subjects as plane and ship design, aerostatics and aerodynamics. With the passage of the Air Commerce Act in 1926, which placed responsibility for airport construction on the municipal governments, there arose a need for a new type of information. What are the requirements for an airport, what equipment does it require, how is it operated and maintained, what construction is necessary, what of the airways themselves, and of intermediate landing fields? By answering these questions, and many more, Lieut. Duke's book admirably meets present needs. It is a guidebook for city governments in a pioneer field, giving the history of airport and airway activity to date, and outlining accepted practice. Much of the information has been published in bulletins of the aeronautics branch, U. S. Chamber of Commerce, but this book represents the first complete compilation of data. Lieut. Duke's position for the past two years as chief, airways section, army air corps, lends assurance as to his ability to discuss the subject, of airports.

Some of the chapter headings are Airport Location, Size and Construction; Airport Equipment; Airport Operation and Maintenance; Airways; Intermediate Landing Fields; Airship Hangars and Mooring Towers; Facilities for Seaplane Operation; Aerial Navigation Maps; Aeronautical Bulletins, Aerial Identification of Cities; Lighting Equipment; and Aerial Regulations.

The book should provide the city engineer and the constructor with the necessary information to talk intelligently on the subject of airports, and to approve or criticize the many proposals that are foisted upon him. He will still have to look to fundamental technical knowledge and to construction common sense to actually bring the airports to life.

Hydraulics of Artificial Channels

REVIEWED BY ROBERT E. HORTON
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WATER CHANNELS—By George Higgins, M.C.E., University of Melbourne, M.Inst.C.E., M.Am.Soc.C.E. Formerly Lecturer on Civil Engineering at the University of Melbourne. Author of "Centrifugal Pumps." London: Crosby, Lockwood and Son. Cloth; 9x11 in.; pp. 108; 16 plates, besides 7 diagrams and 32 figures in the text. 21 sh. net in England.

From an English viewpoint this volume presents the latest theory and practice relative to the hydraulic design of artificial channels for conveying water.

The book opens with a concise review of the leading types of slope formulas for determining velocity in channels, including a number of the later formulæ, and an interesting suggestion, credited to W. A. Robertson, as to an adaption of the Kutter formula, similar to that of Manning, applicable under certain conditions. The author frequently uses the term "area-border ratio" in place of the term "hydraulic radius." Many hydraulic engineers have no doubt felt that the term "hydraulic radius" is somewhat unsatisfactory. This feeling is likely to become pointed when an engineer is on the witness stand and is called upon to explain the term to a jury. It may be claimed for the expression "area-border ratio" that it more directly suggests the relation of the term to friction loss. Whether or not this substitute expression will come into general use remains to be seen.

The second and third chapters relate to the hydraulic elements of the economic cross-section and to circular and egg-shaped channel sections. An interesting bit of theory is added in which is given the equation (that of the catenary) for a section having a constant area-border ratio or hydraulic radius.

There follows a chapter on the lintearia section or hydrostatic trough. A brief discussion of this section appeared years ago in De Volson Wood's Analytical Mechanics but the material given is substantially all new and will certainly be novel to most American engineers. The treatment is as simple and clear as is consistent with the mathematical relations involved and is accompanied by several good diagrams for the solution of problems involving channels having this form of section. Since a semi-circular steel flume of a type not infrequently used in irrigation work tends to approximate a lintearia section, the author's presentation of the subject is timely and valuable.

The fifth chapter of the book, relating to the movement of solids by water, is based almost wholly on Kennedy's formula. As the book is elsewhere well up to date it is surprising that recent studies and advances in the matter of silt and scour are not mentioned, such, for example, as Griffith's paper, A Theory of Silt and Scour (*Inst. C. E.*, Sessional Notices No. 1, October, 1926) and the symposium comprising the views of various East Indian engineers on this subject in the *Technical Review*, Irrigation Branch, Punjab, 1925. These pub-

lications may, however, have appeared while the present book was in press.

The chapters on offtakes from rivers contain a number of interesting examples of low diversion dams with movable crests. In connection with gagings of outflow or diversion, details are given of a built-in type of venturi meter forming part of the outlet works of either earth or masonry dams.

Appendix I contains a brief statement of the theory of the standing wave in relation to its application to the prevention of scour below dams. The discussion is based in part on the experimental work of the Miami Conservancy District and on the experiments of Gibson. The second appendix contains a number of clearly legible diagrams for the solution of the Kutter and Bazin formulas and a note based on a suggestion of Felice Contessini as to a method of applying experimental data of flow in channels and deriving formulas of the Hagen or Manning type therefrom.

A considerable portion of the material contained in the book is not readily available elsewhere. The book is clearly written, well printed, the diagrams unusually good and the work will undoubtedly be found useful, particularly to engineers having unusual or special problems of canal or channel design.

Measurement of Business Cycles

BUSINESS CYCLES AND BUSINESS MEASUREMENTS: Studies in Quantitative Economics—By Carl Snyder. New York: The Macmillan Co. Cloth; 6x9 in.; pp. 326; 56 charts, 34 tables. $6.

The measurement of business in its relation to business cycles rather than cycles themselves, their causes, prediction and control, is the main subject of this book. After chapters on the nature of Business Cycles and on Economic Growth, the author takes up Measurements, Index Numbers, a New Measure for Volume of Trade, Bank Clearings, Velocity of Bank Deposits, the 'Deflated' Dollar, Business Failures, Prices and the Interest Rate. Only 7 pp., finally, are devoted to Forecasting Business Cycles. Numerous tables and diagrams are given.

The "new measure for volume of trade" is a composite index of "56 series" which together represent "the total volume of trade, by months, back to the beginning of 1919," the elements in each series corrected for variations noted. The 56 elements are combined into five groups, each weighted. Totals for the five are: Productive activity, 29 per cent; primary distribution, 22; distribution to consumers, 26; general business activity, 17; financial activity, 6 per cent. As to forecasting business cycles the author says:

> All things considered, then, the various methods of forecasting have not given highly satisfactory results. . . . But the importance of an intelligent analysis of the various factors of the business cycle, a measure of their intensity, an understanding of their changing relationships, and an exact quantitative expression of the measurement of economic events should lead to a much more intelligent prevision of business, and to a lessening of the severity of business cycles. Within reasonable limits we can now understand what is happening, and what has happened, and we can estimate roughly what is going to happen. And it is through measures of the type described in the preceding chapters that much can be done toward the intelligent understanding that should eventually lead to control of the business cycle.

The book abounds with tables and charts, supplemented by extensive notes. It deserves the careful attention of students of business and economics as well as the "captains of industry" and their engineer lieutenants.

Æsthetics of Drinking Water

REVIEWED BY ABEL WOLMAN
Chief Engineer, Maryland Department of Health, Baltimore, Md.

THE MICROSCOPY OF DRINKING WATER—By George Chandler Whipple, Late Gordon McKay Professor of Sanitary Engineering, Harvard University; Revised by Gordon Maskew Fair, Assistant Professor of Sanitary Engineering, and Melville Conley Whipple, Assistant Professor of Sanitary Chemistry, both of Harvard University. Fourth Edition, Rewritten and Enlarged. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 6x10 in.; pp. 586; 123 line cuts and halftones, 7 plates in text and 19 colored plates, with descriptions, at end of book. $7.

"Our cities need water of such quality that the people not only can drink it with safety, but will drink it with pleasure." Thus in the third edition of his "The Microscopy of Drinking Water," did the late Professor Whipple express the underlying motive in the preparation of his "The Microscopy of Drinking Water." Through the first edition, published over a quarter century ago he first made available to the profession this "vade mecum" intended, and widely used, as guide to analyst and engineer and as a stimulant to greater interest in the life history and importance of microscopic aquatic life. Since that time much scientific progress in the principles suggested by Whipple has been made and those principles have been applied to an appreicable extent. The responsible authorities in water-supply control, however, have not yet fully grasped the axiom that providing pleasure, no less than safety, in drinking water is their concern and increasingly the demand of the public. Some workers have devoted time and energy to these phases of water-supply technology, but many others still view the too frequent visitations of malodorous organisms as acts of God, to be feared but also to be accepted with humble prayer. To those who have learned in a measure to understand the "devious ways" of these interesting biologic forms, it is no exaggeration to say that Whipple's Microscopy has been the inspiration. How, then, does this new volume bring them forward, a volume conceived and produced as a labor of love by Whipple's assistants, Fair and M. C. Whipple?

The present volume is not, to the reviewer, a revision. It is a new book, almost twice the length of the first and one and a half times that of the third edition. In this enlargement and revision may appear either its future strength or weakness in making more generally useful its important principles. The old title seems almost too limited for the scope of the book, while the effort to appeal to both the general reader and the specialist results in a volume of considerable bulk. The wider application of the facts, so ably and interestingly presented, might be better consummated, if the book were to appear in two separate volumes, the one dealing with Applied Microscopy (incidentally covering a surprisingly varied group of topics) and the other with Determinative Microscopy. The former would be of interest to the general reader, while the latter would meet the requirements of the specialist. Whether this arrangement would be worth-while is dependent, of course, upon whether or not the revisers preserved the intent of the original author to stimulate interest rather than to expound detailed principles and facts.

In the development of such an extensive volume, it necessarily has followed that some of the simplicity of word and style of Prof. Whipple has been lost. But this, perhaps, must give way to the more elaborated and complete data which replace it. At times, however, the inclusion of tabular and graphic material, though useful and pertinent, appears somewhat unnecessarily complete

in supporting the text. Whether or not more familiar terms in English might not replace with profit more abstruse and more scientific Greek and Latin terminology is again a matter of individual taste. The present reviewer, for example, suggests that "rheology" may scare off the water-works superintendent, while "the science of stream characteristics" may entice him to read on. But such notations are purely minor in discussing a volume so uniformly excellent in treatment, so carefully arranged and so thoroughly covering the subject.

It is impossible to do more here than indicate the direction in which this volume differs from its predecessor. A general survey has been introduced of the development of microscopical science. New material, extending in some instances to entirely new chapters, has been added on microscopic organisms and sanitary water analysis; on chlorination odors and tastes; records of examination; physical, chemical and biological conditions in lakes; the characteristics and phenomena of flowing waters; the self-purification of streams; control of algæ by copper sulphate and chlorine; algæ in water purification; and on microscopic organisms in water conduits.

An important and instructive addition has been made in Part II by the thorough classification of some thousand organisms with respect to their environment. Sanitarians particularly should find this section profitable. Its preparation was obviously a stupendous task.

Sufficient has been said, even within this limited space, to make clear that the volume under discussion, treating a series of subjects profoundly important to water-supply superintendent, sewage-works operator, sanitary engineer, conservationist, laboratorian and others, conceived on a vast scale, has been completed in a style calculated to do honor to the preceptor of the revisers. A volume thorough in treatment, scientific in attitude, clear and interesting in style, and conservative in principles is a worthy successor to the first Microscopy of Drinking Water.

Autobiography of a British Contractor

THE CHRONICLES OF A CONTRACTOR: Being the Autobiography of the Late George Pauling—Edited by David Buchan; with an Introduction by J. O. P. Bland. London (England): Constable & Co., Ltd. Cloth; 6x9 in.; pp. 240; frontis portrait. 10s. 6d.

Most of us know contractors whose life story would be read with interest and profit. There are few, however, who have the ambition to write that story. George Pauling, whose autobiography this book is, is one of the few, and he and his editor have made an interesting account of an active life of construction work in South Africa, South America, India, and China. Pauling was of the contractor type which tradition makes fond to memory—a venturer, a good liver, a sport, a lover of a fight, a cunning business man, a philosopher, something of a brag, and a good fellow. All these qualities stand out in the naïve wording of his autobiography. Knowing nothing of the man previously, the reviewer read his life story with enjoyment.

Guidance From Those Who Have Achieved

AN OUTLINE OF CAREERS: A Practical Guide to Achievement—By Thirty-Eight Eminent Americans. Edited by Edward L. Bernays, Author of "Crystallizing Public Opinion," etc. New York; George H. Doran Co. Cloth; 6x10 in.; pp. 431. $5.

Thirty-eight eminently successful men and women have each contributed a section to this volume. The book should prove both interesting and valuable to young students who wish to select their occupation on a basis of suitability rather than rapid advancement or large remuneration.

The career in engineering, which is presented by John Hays Hammond, should be of particular interest to engineers and students of engineering. Mr. Hammond, who started his career as a mining engineer, feels that the one-sided tendencies of an engineering education should be offset by general study in other fields. He lists the following subjects in the order of their importance: English language and literature; a foreign language; economics, finance and commerce; government and political science; general domestic law; history; sociology; philosophy and logic; art and physiology.

Efficiency in Road Building

MANAGEMENT AND METHODS IN CONCRETE HIGHWAY CONSTRUCTION—By J. L. Harrison, Highway Engineer, U. S. Bureau of Public Roads. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 242; 74 halftones and line cuts. $3.

Twenty years ago this book would have been labeled efficiency engineering, or scientific management, in road building. Now it is titled simply management and methods in concrete road construction. Incidentally it has to do more with management than with methods in so far as these are separable functions in road building or, indeed, in any construction operation.

Briefly, some three years ago the Bureau of Public Roads undertook a study of concrete road construction machines and methods. An investigation was made first of roadbed grading and then of pavement laying. The author had the immediate direction of these investigations. He employed all the methods of breaking down construction processes into their component operations and of timing these operations and disclosing their relations to each other and to the process as a whole. Then, when he could, he built up the combination of determined factors which constituted an ideal operation and tested it out. The studies made and the conclusions reached were reported as a series of articles in "Public Roads," which have become known to every highway engineer. The present book is the condensation of this elaborate study into a meaty volume of 242 pages. It is as concentrated a bit of engineering text as there has been occasion to notice in a long time. This merits attention at a time when engineering authors seem to be seeking volume of text and departing from close editing.

Taking up in order the subjects discussed they are: Planning conduct of work, production management, purchasing aggregate for yield, preparing subgrade, fine grading and form setting, handling aggregate and cement, proper truck supply, hauling to mixers by truck, field stock piling, hauling to mixer by industrial railway, final fine grading, operation of mixers, water in mixing and curing, finishing and curing, origin and cost of overruns, and organization and equipment.

The contractor who reads these chapters will find, like the man who discovered he had been talking English literature all his life, that he has been in a way doing all the things that they lay down as being necessary to do. The criticism of his work, he will find, is that he has not been orderly, logical, and precise, in its performance. He will often declare that such precision of co-ordination cannot be accomplished. The book says it can be and has been accomplished. Wherever between the two, the truth may lie, the contractor who reads the book will have his complacency prodded and this will do him a world of good.

Publications Received

THE OFFICE AND FILING SYSTEM of the Mails and Files Section of the Washington Office, U. S. Bureau of Reclamation, is described in a 52-p. pamphlet issued by the Department of the Interior. Most of the pamphlet deals with filing in which the decimal system is followed.

THE AUTHOR or Nomograms for Hydraulic and Other Calculations Occurring in Irrigation Work, noticed in these columns on Oct. 18, 1927, p. 277, is E. S. Lindley instead of P. Brindley. After the book was forwarded for review Mr. Lindley left the Panjab Irrigation Department. He may now be addressed care of Thomas Cook and Son, Berkeley St., Picadilly W. 1, London, England.

MANY READERS will be surprised to learn that irrigation is practiced to a sufficient extent in the eastern part of the United States to warrant the publication of a Farmers Bulletin (No. 1529) on the subject by the U. S. Department of Agriculture. Some 25 pp. are filled with text, tables and illustrations, all seemingly devoted to spray irrigation (5c. from Superintendent of Documents, Washington, D. C.).

A STUDY of Air-Seasoning and Conditioning of Timber is the subject of Special Report No. 1 of the Forest Products Research Laboratory, operated under the jurisdiction of the British Department of Scientific and Industrial Research. This study has been prepared by Major F. M. Oliphant, assistant director of forest products research. It is mostly general in character but contains some statistical data (2 sh. from H. M. Stationery Office, Westminster, London, W. S. 1, England).

FOUR VOLUMES, in Russian, with résumé in French, on the exhaustive study recently made for determining the possibility of developing an additional potable water supply for the city of Moscow, Russia, from the Volga and Oka basins, have been published by the Communal Commission, Department of Water, Moscow, Russia. The investigation includes (1) utilization of the Volga and Oka direct as compared with impounding tributary waters; (2) possibilities of amplifying the Volga and Oka supply by impounding tributary streams; (3) bacterial and hydro-biologic studies; (4) chemical researches; and (5) results of filtration of water from the Volga and Oka in a number of experimental stages.

LABORATORY TESTS on Physical Properties of Water-Bearing Materials, by Norah Dowell Stearns, is the subject of a 55-p. reprint from Contributions of the Hydrology of the United States, 1927, which is issued as Water-Supply Paper 596-S (U. S. Geological Survey, Washington, D. C.). The paper describes apparatus and methods used in determining the mechanical composition, porosity, moisture equivalents, and permeability, and gives the resulting data, of 97 samples collected in New Jersey, Montana and Idaho. Some interpretative comments are included. The studies were designed to supplement what the author terms "the classic researches of Hazen, King and Slichter" which is stated to have "been the chief basis of any quantitative estimate in this field in this country."

THE SPECIAL COMMITTEE nominated in 1916 by the Institution of Civil Engineers has made its seventh interim report on The Deterioration of Structures in Sea Water. Observations are reported on specimens of iron and steel submerged at Colombo, Plymouth, Halifax, Auckland; on steel placed with protective coating at Southhampton; on timber blocks and other timber exposed at various places; on mechanical tests of certain foreign timbers, both untreated and creosoted. There are also abstracts of reports and correspondence relating to the corrosion of steel girders and on observations of marine piling, the latter by the American Railway Engineering Association. These investigations are conducted with financial assistance from the Department of Scientific & Industrial Research of the British Government (2 sh. from H. M. Stationery Office, Westminster, London, S. W. 1, England).

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ARCHITECTURAL DESIGN IN CONCRETE—By T. P. Bennett, F.R.I.B.A. The Photographs Compiled by F. R. Yerbury, Hon. A.R.I.B.A. New York: Oxford University Press, American Branch. [Printed and made in Great Britain.] Cloth; 9x11 in.; pp. 25 + 100 halftone plates. $10.

ARCHIV FÜR EISENBAHNWESEN—Herausgegeben in der Hauptverwaltung Der Deutschen Reichsbahn-Gesellschaft. Jahrgang 1927—Heft 1, Januar—Februar. Berlin: Julius Springer. Paper; 7x10; in.; pp. 256.

ERLÄUTERUNGEN AU DEN EISENBETON-BESTIMMUNGEN 1925 mit BEISPIELEN—By Dr.-Ing. W. Gehler, ord. Professor an der Techn. Hochschule Dresden und Direktor der bautechn. Abteilung des Versuchs-und Materialprüfungsamtes (Vierte neu bearbeitete und erganzte auflage) Berlin: Wilhelm Ernst & Sohn. Paper; 5x7 in.; pp. 218; with 99 linecuts.

GUIDE PRATIQUE DE LA PROSPECTION DES MINES et de Leur Mise en Valeur—Par Maurice Lecomte-Denis, Ingenieur Civil des Mines. Fourth edition, enlarged. Paris: Dunod (92 Rue Bonaparte VI). Paper; 7x10 in.; pp. 697.

INTERPOLATION—By J. F. Steffensen, Sc.D., Professor of Actuarial Science at the University of Copenhagen. Baltimore, Md.: The Williams & Wilkins Co. Cloth; 6 x 9 in.; pp. 248; line cuts, tables. $8.

IST GUSSBETON WIRTSCHAFTLICH?—Unterschungen über die Wirtschaftlichkeit von Gussbeton gegenüber Stampfbeton—By Dr.-Ing. L. Baumeister, Stuttgart. Berlin: Julius Springer. Cloth; 6 x 9 in.; pp. 100; 43 illustrations, 14 tables. Paper 7.6 reichmarks; Cloth, 7.1 reichmarks.

LILLA EDETS KRAFTVERK: Och Provning av Dess Turbiner (Teniska Meddelanden Fran Kungl. Vattenfallsstyrelsen) Ser. B, N:R13. Utkom Den 1 Mars 1927. Stockholm: Centraltryckeriet. Paper; 6 x 9 in.; pp. 62.

MANUAL OF ACCIDENT PREVENTION IN CONSTRUCTION. Washington, D. C.: Associated General Contractors (1150 Munsey Building). Paper; 9x11 in.; pp. 51; display illustrations. $1. Outlines the policy of accident prevention advocated by the Associated General Contractors and reprints the code of safe practices employed by the Detroit chapter of the association.

QUALITY OF SURFACE WATERS OF NEW JERSEY. Water Supply Paper 596-E, U. S. Geological Survey, Washington, D. C. Paper; 6x9 in.; pp. 119; map.

METHODS OF THE CHEMISTS OF THE UNITED STATES STEEL Corporation for the Sampling and Analysis of Gases. Third Edition. Pittsburgh, Pa.: Carnegie Steel Co., Bureau of Instruction. Light board; 6 x 9 in.; pp. 187; 25 line cuts and halftones; tables. $2.

NEUERE METHODEN ZUR STATIK DER RAHMENTRAGWERKE—By A. Strassner, Oberingenieur. Drette neubearbeitete Auflage. Zweiter Band Der Bogen und das Brückengewölbe. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 171; with 102 line cuts and 56 tables. 12 reichmarks.

NOMOGRAPHIE DES BAUINGENIEURS — By Dr.-Ing. Max Mayer, Beratendem Ingenieur und Professor an der Staatl. Bau-Hochschule in Weimar. Berlin and Leipzig: Walter de Gruyter & Co. Cloth; 4x6 in.; pp. 111; 47 illustrations.

REDOGÖRELSE FÖR ARBETENA MED TROLLHÄTTE KRAFTVERKS FÖRSTA, ANDRA OCKH TREDJE UTBYGGNADER: effer utgangen av ar 1910. Trollhättans Tryckeri Arktiebolag 1927. Stockholm. Paper; 6x9 in.; pp. 143; 65 line cuts, 20 plates.

THE SLIDE RULE: A Practical Manual—By Charles N. Pickworth. Eighteenth Edition, Revised and Partly Rewritten. New York: D. Van Nostrand Co.; London or Manchester (England): Emmott & Co., Ltd. Cloth; 5x8 in.; pp. 134; 36 line cuts. $1.50 (New York), 2s.16d. (England).

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Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Toe Erosion Below Overfall Dams

Sir—Your editorial dealing with toe erosion below overfall dams, in the issue of Oct. 20, 1927, p. 617, touches a very important matter, so important that I venture to submit a few additional comments.

The use of the hydraulic jump in a suitable, controlled form is undoubtedly the most convenient, sure, and efficient method of dissipating the dangerous kinetic energy in a large stream of rapidly moving water. There is some lack of agreement among authorities as to just what phenomenon should be considered to be the typical hydraulic jump, but probably all will agree that the jump occurs in its most definite, striking, and conspicuous form when it is produced on a practically level floor by a stream of water moving with a high velocity striking against a higher wall of relatively quiet water. In this typical jump the moving stream is transformed into a white mass of foam, in which there is a complete, intimate, and almost homogeneous, mixture of air and water, leading to a nearly instantaneous transformation of the kinetic energy into heat, so that the outflowing water moves away in a quiet, placid stream with a uniform, low velocity everywhere throughout its cross section.

The whole phenomenon occupies a surprisingly small space, which is one of its great practical advantages. In order that the jump may form, however, there must be a definite mathematical relation between the depth and velocity of the high velocity stream and the depth of the tailwater. Unless this relation is met the jump cannot exist. The easiest way to insure the formation of the jump, is to provide a sloping floor so that by moving up or down the slope the jump may automatically adjust itself to such position as will provide the needed depth of tailwater. While a sloping floor provides a convenient automatic regulation of the jump, it has the disadvantage that if the floor is given much slope the nature of the jump is modified. If the slope is made greater than one on three, experiments indicate that the certainty and effectiveness of the jump in destroying energy are perceptibly reduced. If the slope is made as steep as 45 deg., the usefulness of the jump is mostly lost. The tail water becomes very turbulent, and large bodies of water pass down stream in various and uncertain submerged paths without having lost their dangerous kinetic energy. Under such conditions serious erosion of the stream bed is almost certain to occur.

The chief reasons why dangerous erosion has occurred below overfall dams and has not been prevented by the hydraulic jump seem to have been two. Either the slope of the front toe of the dam at the water line has been too steep to produce an effective jump, or its elevation has been too high with respect to the tailwater level below the dam. An essential requirement is that the floor upon which the jump is to form must be below tailwater level a sufficient distance to provide the depth needed by the jump.

To illustrate this point consider water going over the top of a dam with a smooth rounded crest, the depth on the crest being 10 ft. If the dam is 100 ft. high and has a smooth face the velocity of the falling sheet at the bottom will be about 80 ft. per second and its thickness about 1½ ft. This would produce a hydraulic jump over 20 ft. high, and the water would flow away below the jump with a velocity of only 5 ft. per second. To insure the formation of this jump, then, it would be necessary to make sure that the tailwater below the dam under these conditions of flow should be nearly 25 ft. above the top of the apron. In the case of some overflow dams the apron below the dam was not put at a low enough elevation to make possible a hydraulic jump on the apron. The high velocity sheet of water then moves across the apron with but little loss of velocity, and expends all its energy on injurious erosion below the apron.

Experiments do not indicate that the hydraulic jump is a severe tax upon or test of the strength of the floor upon which it forms. Most of the energy is consumed in strictly internal impact within the mass of the water itself. It is almost completely self-contained. A reasonably heavy, sound, and solid floor is sufficient.

Apparently the merits of the hydraulic jump as an energy destroyer have not always been understood. Probably most of the damage from erosion below overfall dams could have been avoided, if their constructors had understood the detailed arrangements necessary to secure the formation of a hydraulic jump in a controlled position and had been willing to incur the moderate expenditure required.

SHERMAN M. WOODWARD,
Professor of Mechanics and Hydraulics,
University of Iowa.

Iowa City, Iowa,
Oct. 29, 1927.

Bridges and Shipping: An Early Case

Sir—Your editorial on "Bridge Piers and Navigation" with the article on Carquinez Bridge fenders in the Nov. 17 issue brings to mind the Rock Island bridge case, many years ago, in which the rights of shipping interests and railways were in dispute.

The first railway bridge to span the Mississippi River extended from Rock Island, Ill., across the main channel to Davenport, Iowa. The bridge was opened to traffic in April, 1856. Two weeks later the steamboat "Afton" struck one of the piers, was wrecked, and was destroyed by fire, which also burned a part of the bridge span. The owners of the Afton sued in the federal court for damages, putting forward two points:

1. That the river was a great waterway and could not legally be obstructed by a bridge;

2. That this particular bridge was so located as to make it a peril to all water craft and an unnecessary obstruction.

The Rock Island company retained Abraham Lincoln to defend the case. Lincoln contended that "one man had as good a right to cross a river as another had to sail up or down it," and in view of the great growing amount of traffic east and west he should not be restricted to crossing it by canoe or ferryboat.

Feeling against the building of a bridge among the river men had been bitter, and it is related that when the bridge span fell (from fire), there was a shouting, ringing of bells, and a greater celebration than follows an exciting election. When again in service, the bridge carried in the first eleven months 12,856 freight cars and 74,179 passengers.

The lawsuit was appealed to the Supreme Court, which permitted the bridge to remain.

The preceding is largely from Starr's book "Lincoln and the Railroads."

Syracuse, N. Y.,
Nov. 26, 1927.

S. L. PEEBLES.

New England Flood Rainfall Surpassed in Central States in 1913

Sir—In the editorial comment preceding the article on "Flood Rainfall in New England" by Prof. H. K. Barrows, in your issue of Nov. 17, it is stated that the New England storm "was more intense than the storm which caused the memorable floods in the Central States on March 24-26, 1913, the motive for the construction of the elaborate flood-protection work on the Miami River in Ohio. The 2-day precipitation in Vermont equaled the 3-day precipitation in the Miami area."

In the same issue, page 810, in J. R. Freeman's letter, there appears the following interjection by the editor. "This appears questionable, as the Miami 3-day total for a 4,000-

mile area was 6.94 in., as reported in *Engineering News* of Jan. 4, 1917, page 13, while Prof. Barrows in the present issue reports a two-day total of nearly 7 in. for a corresponding area."

Reference to *Engineering News* of Jan. 4, 1917, page 13, shows that the 6.94 in. applies to runoff, not rainfall. On page 14, Fig. 5, of the same article are shown 3-day rainfall area-depth curves for a number of storms. From curve 4, which is for the 1913 Ohio storm, it may be seen that the 3-day rainfall for a 4,000 square mile area was nearly 9 in.

In Technical Reports of the Miami Conservancy District Part VII, page 43, the table shows that the maximum 2-day rainfall during the Ohio storm of 1913 for a 4,000 mile area was 8.0 in. and the one-day rainfall for the same area 5.8 in. The area-rainfall curves on page 797 of Prof. Barrows' article show that in the New England storm the total rainfall for a 4,000 mile area was about 6.4 in. and that the one-day maximum for this area was approximately 5.4 inches.

Dayton, Ohio,
Nov. 26, 1927.

C. H. EIFFERT,
Chief Engineer,
Miami Conservancy District.

Splice Failure in a Wooden Truss

Sir—I don't seem to be able to check the stresses given in an article headed "Portland Building Failure Due to Splice of Wooden Truss," in your issue of Nov. 17, p. 805. According to the panel loads given the splice must have been a fairly good one after all.

Probably I have overlooked something. If the author of the article will clear this up the readers will not be mixed up on the strength of a joint of the type shown.

Flint, Mich.,
Nov. 22, 1927.

D. M. MCCAIN.

Engineering Salaries and the Unions

In regard to the letter appearing in the Nov. 3 issue captioned "Unionization of Engineers," permit me to say:

If the engineer-executive is responsible for the majority of the lamented ills that prevail in the profession, then he has been influenced to neglect the general welfare of his under-engineer employees, not by oversight or inability or authority to act but by the sheer reason of selfish motives. The assistants have been denied a social, professional and financial prestige that he alone may be exclusive, and enjoy this distinction. About one engineer out of ten is interested in the advancement of his men. Seldom do they use any effort, good will or influence to have their men become members of a professional organization of their own affiliation. If he is not concerned about the progress of his men, surely he is not interested in extending to them a proper compensation for their useful and loyal services.

It is not necessary that an engineer-executive force higher budgets on his superiors by aid of high pressure methods. He is usually vested with the authority to meet the pay rolls of his highly paid laborers and tradesmen and all others he wishes to employ. If he can do this with a smile for hundreds of men, there is no logical reason for his not being able to grant or secure a living and equitable salary to the under employees of his own profession that assist in the direction and supervision of his departmental forces. One of the most plaintive and appalling conditions that occurs in the profession is when an engineer-executive places his assistants in charge of a project to act as his own representative at a less compensation than received by the greater portion of the men he has to supervise.

Labor unions do get results. The lowest salary paid to the engineer forces of the city and county of San Francisco is a minimum of $225 per month. The writer cannot state the number of its members that belongs to the Engineers & Draftsmans Union, but he does know that it is considerable. The salary of the rodman and chainman of the city is even larger than the average paid to the experienced engineers of private and corporation forces. This statement deals with a condition and is not to be construed as an assertion that members of the profession are favorable to the unions. When inspectors, barbers, scavengers, street car conductors, street sweepers and a thousand and one what-nots receive a greater compensation for their services than the man that designs and constructs great engineering achievements, no reproach should be given him should he choose to go outside of his profession for assistance and benefit that has been denied to him by his employer.

San Francisco, Calif.,
Nov. 12, 1927.

J. R. W.

Sir—Your columns have recently carried several expressions of opinion suggesting remedies for the deplorable *status quo* of the engineer. Unionization or its "moral equivalent" has been suggested as a panacea. The views presented pave the way for further discussion and the writer sincerely hopes that more general attention from all branches and walks of the profession may be focused upon the question. It has been stated that the position of the engineer is not exactly an enviable one. An exchange of serious, constructive thought in your columns would throw some light upon that statement and tend to prove or disprove it. If general opinion bears out the statement, then perhaps a satisfactory solution of this problem of fitting recognition and adequate remuneration may be offered, a solution which will appeal to the rank and file of the engineers in a better way than trade union tactics.

It is not difficult to see why labor union organizers are making such an effective appeal to many engineers. Collective bargaining by the organized trades has brought them immense returns. It is only natural that groups of engineers in the larger cities have allowed themselves to be influenced by union organizers to the extent of forming locals under the American Federation of Labor. But it is extremely unfortunate, for engineering has a professional, scientific aspect which sets it distinctly apart from the skilled trades. It is a blow to the profession that members thereof should publicly announce themselves as tradesmen. Because a plumber chooses to style himself a sanitary engineer to cloak himself with a technical duster, should a sanitary engineer call himself a plumber to get a plumber's wage? If that is to be the ultimate result in all branches of engineering, then it is time to convert our engineering colleges into vocational schools. Yet, one cannot severely condemn our engineer colleagues who choose to unionize. Living costs in big cities are high—and professional pride is not a convertible asset. The trade union with its organized strength apparently offered the best solution to the problem at hand.

Are there not better ways than this however? Is it not possible that some medium or agency may be found through which the strength of organized effort may be exerted without the sacrifice of professional pride? What road may be followed to bring society to a proper appreciation of the enormous responsibility and trust they place in the engineer? Two events of recent occurrence send out a ray of hope. The recent action of the Board of Direction of the American Society of Civil Engineers in rendering aid to the engineering employees of the city of New York points to one possible channel of relief. The ceremonies attendant upon the recent opening of the Holland Tunnel suggests the possibilities which would result from placing the engineer and his work more in the public eye. The prominent position of the engineer at that celebration was unique and unprecedented. The homage paid to the engineer by the assemblage present indicates the existence of a subsconscious appreciation that needs only the light of publicity to be stirred into the flame of just recognition radiating tangible rewards.

Urbana, Ill.
Nov. 28, 1927.

HAROLD E. WESSMAN,
Instructor in Civil Engineering,
University of Illinois.

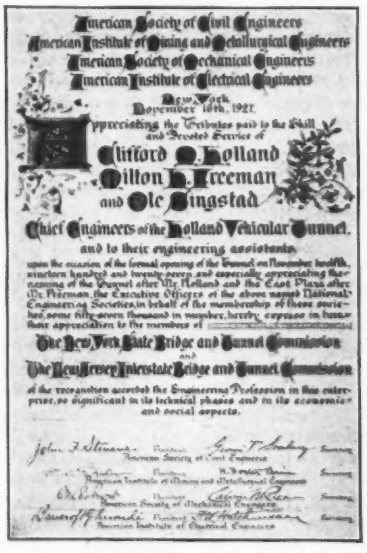
News of the Week

Current Events in the Civil Engineering and Contracting Fields

Founder Societies Present Tunnel Commission With Appreciative Resolution

In appreciation of the commendation which it has given engineers connected with the design and construction of the Holland Tunnel, the four founder societies presented on Dec. 13 an engrossed resolution to the New York and New Jersey bridge and tunnel commissions. The presentation was made by Col. W. T. Chevalier, general manager of the construction group of the McGraw-Hill papers, who represented Secretary Seabury of the American Society of Civil Engineers. The resolution was presented to Gen. George R. Dyer, chairman of the New York commission, and to Theodore Boettger, chairman of the New Jersey commission at the Holland Tunnel offices.

The appreciation, bearing the signatures of John F. Stevens and George T. Seabury, president and secretary of the American Society of Civil Engineers; E. De Golyer and H. Foster Bain, president and secretary of the American Institute of Mining and Metallurgical Engineers; C. M. Schwab and Calvin W. Rice, president and secretary of the American Society of Mechanical Engineers; and Bancroft Gherardi and F. L. Hutchinson, president and secretary of the American Institute of Electrical Engineers, is as follows:


American Society of Civil Engineers
American Institute of Mining and Metallurgical Engineers
American Society of Mechanical Engineers
American Institute of Electrical Engineers

New York
November 10th, 1927

appreciating the Tributes paid to the Skill and Devoted Service of

Clifford M. Holland
Milton H. Freeman
and Ole Singstad

Chief Engineers of the Holland Vehicular Tunnel,
and to their engineering assistants,

upon the occasion of the formal opening of the Tunnel on November twelfth, nineteen hundred and twenty-seven, and especially appreciating the naming of the Tunnel after Mr. Holland and the East Plaza after Mr. Freeman, the Executive Officers of the above named National Engineering Societies, in behalf of the membership of these societies, some fifty-seven thousand in number, hereby express in human appreciation to the members of

The New York State Bridge and Tunnel Commission
and
The New Jersey Interstate Bridge and Tunnel Commission

of the recognition accorded the Engineering Profession in this enterprise, so significant in its technical phases and in its economic and social aspects.

FACSIMILE OF RESOLUTION

Appreciating the tributes paid to the skill and devoted service of Clifford M. Holland, Milton H. Freeman and Ole Singstad, chief engineers of the Holland Vehicular Tunnel, and to their engineering assistants, upon the occasion of the formal opening of the Tunnel on Nov. 12, 1927, and especially appreciating the naming of the Tunnel after Mr. Holland, and the East Plaza after Mr. Freeman, the Executive Officers of the above named National Engineering Societies, in behalf of the membership of these societies, some fifty-seven thousand in number, hereby express in turn their appreciation to the members of The New York State Bridge and Tunnel Commission and The New Jersey Interstate Bridge and Tunnel Commission of the recognition accorded the Engineering Profession in this enterprise, so significant in its technical phases and in its economic and social aspects.

In making the presentation, Colonel Chevalier emphasized the appreciation of engineers generally for such high recognition of the part of lay bodies for engineering service.

Brief News

SALES OF STATE AND MUNICIPAL bonds for the first 10 months this year were the highest for any corresponding period during the last five years, according to the *Commercial & Financial Chronicle*. Total sales stood at $1,236,598,211, representing an increase of $87,513,193 over the first 10 months of 1926.

CONTRACT FOR BUILDING a $1,000,000 branch Ford plant in Yokohama, Japan, with a capacity of 200 cars a day, has been awarded to the H. K. Ferguson Co., Cleveland. The main building will be 300 by 480 ft. with saw-tooth design and insulated roof deck. It is stated that the building will employ the latest principles of earthquake and fire resisting construction.

AN ORDINANCE PROVIDING FOR THE APPOINTMENT of 15 additional engineers to carry out the city's program of sewer construction was adopted by the city council of Columbus, Ohio, recently. Salaries range from $225 to $334.34 per month.

THE LOWEST BID FOR CONSTRUCTING the Conklinville dam at Hadley, N. Y., for impounding the waters of Sacandaga reservoir was submitted on Dec. 5 to the Hudson River Regulating District by S. J. Growes & Son, Ticonderoga, N. Y. The dam is part of a total of approximately $9,000,000 which will be spent on regulation of the Hudson.

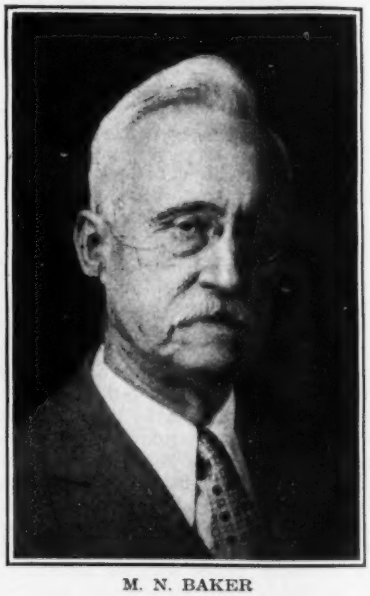
APPLICATION of the Tyrone Bridge Co., Inc., Lawrenceburg, Ky., for approval of plans for a bridge to be constructed over the Kentucky River at Tyrone, four miles east of Lawrenceburg, has been approved by the assistant secretary of war.

M. N. Baker Is Honored On Completing 40 Years of Journalistic Service

M. N. Baker, associate editor of *Engineering News-Record,* was the guest of honor at a dinner given by about 100 of his associates in the McGraw-Hill Co. at the Engineers Club, New York City, Dec. 9, in celebration of his fortieth year of continuous editorial service with *Engineering News* and *Engineering News-Record.*

Mr. Baker started in engineering journalism with *Engineering News* when Arthur M. Wellington was editor. One of his first achievements was the building up of a water-works year book (The Manual of American Water-Works), which long was a basic source of information regarding the water-works of the United States and Canada. Out of this year book grew Mr. Baker's special and editorial attention to questions of water purification, sewage and garbage disposal and other phases of public health and sanitation which were then first beginning to be put on a scientific basis.

HONORED AT COMPLETING 40 YEARS' CONTINUOUS EDITORIAL SERVICE



M. N. BAKER

The speakers at the dinner included W. T. Chevalier, business manager of the construction group of McGraw-Hill papers, who was toastmaster; James H. McGraw, Jr., vice-president and treasurer, who read a letter of appreciation

(*Continued on p. 979*)

Gen. Taylor Retained to Study Florida Inland Waterway

Gen. Harry Taylor, former chief of engineers, has been retained by the State Canal Commission of Florida to assist in the preparation of data for presentation to the Board of Engineers for Rivers and Harbors in an effort to justify an early survey of the Georgia-Florida inland waterway. A preliminary survey of this project was authorized in the last river and harbor bill.

Sargent Resigns from Maine Highway Commission

Paul D. Sargent, for many years chief engineer of the State Highway Commission of Maine, has resigned, effective Jan. 1, 1928. It is understood he has accepted the position as sales manager of the New England Culvert Company of Palmer, Mass.

Mr. Sargent was born in Washington County, Maine, and is a graduate of the University of Maine. He was register of deeds for Washington County in 1905, when he resigned to become Maine's first highway commissioner. He held this position until 1911 when he resigned to join the staff of the U. S. Bureau of Public Roads at Washington. In 1913 he returned to Maine, becoming the first chief engineer under a commission of three, which office was established in that year.

During the 14 years Mr. Sargent has been chief engineer of the Highway Department, he has supervised the construction of more than 1,000 miles of state highway, some 2,000 miles of state-aid roads, and about 700 miles of third class roads.

Mr. Sargent was one of the charter members of the American Association of State Highway Officials. He is also a member of the American Society of Civil Engineers and the American Society for Testing Materials. Last year he was appointed by President Coolidge one of the United States representatives at the annual convention of the International Association of Road Congresses at Milan, Italy.

Central Passenger Terminal Projected in Montreal

Plans have been prepared by the Canadian National Rys. for the establishment of a central passenger station in Montreal. Three large models were recently laid out in the company's offices in Montreal for public inspection. Three-level layout is planned with an office building for the employees of the railway and of allied services. These employees are now scattered throughout Montreal in half a dozen buildings. The station proper will be underground. The whole project as planned will cover four city blocks.

Heavy Rains Again Cause Flood Worry In Vermont Valleys

Winooski River Particularly High at This Season—Temporary Bridge at Waterbury Destroyed

HEAVY rains have again caused the New England rivers, which caused heavy damage in early November through flooding, again to rise to threatening proportions. The Winooski River particularly has risen to an unusual winter height. Reports from Montpelier are to the effect that during the night of Dec. 7-8 the river rose approximately 5 ft., causing it to overtop its banks in places and threaten a temporary bridge of the Central Vermont R.R. near the Montpelier station. This new structure is a pile-supported bridge which replaces a steel span carried out by the early November flood. Débris and logs collected about the piling creating a serious danger, so that it was necessary to use dynamite a number of times to minimize the possibility of its destruction.

Temporary Bridge Destroyed

At Waterbury, it was necessary to dynamite the bridge across the Winooski River connecting Waterbury and Duxbury and leading toward Montpelier. This was done in order to prevent the swollen river from changing its course again and doing further flood damage. A portion of the steelwork of the bridge which went out in early November had been salvaged and was in course of erection.

At Northfield, Vt., heavy rain was reported which caused streams flowing through the town to overflow their banks in several places, inundating cellars. Overflowing of Otter Creek also caused considerable anxiety in and around Rutland. The greatest inconvenience was occasioned in the western part of Rutland County where vehicular traffic was cut off for most of Dec. 7 by the overflowing of the Castleton River. A recent fill on the Rutland R.R. in Wallingford, 12 miles south of Rutland, went out, holding up trains for 3 hr. At Burlington, the Winooski rose more than 5 ft. in less than 24 hr.

All of the upper Connecticut River tributaries and the Connecticut River itself were reported as reaching unusual winter stages. From Brattleboro it was reported that a flow of 35,000 sec.-ft. was attained Dec. 8, as compared with 160,000 sec.-ft. at the height of the flood a month ago. This was at the station of the Connecticut River Power Company at Vernon. At Bellows Falls, a stage of almost 14 ft. was reached at the dam of the New England Power Company; a stage of 27.5 ft. was reached as a crest in the early November flood.

Relief from impending unusual flood damage was had at the end of the week by a sudden drop in temperature.

Vermont Reports No Typhoid for November

According to reports recently received from the Vermont State Board of Health, the health of the state was better for November, 1927, than normal for this month despite the heavy flood damage which was sustained Nov. 3-5. Not a single case of typhoid fever was reported in the entire state during the month, though some water supplies were contaminated by line breakage or flooding.

I.C.C. Wins Support for Valuation Method

The Interstate Commerce Commission, on Dec. 10 in the United States District Court for the Eastern District of Missouri, won the first victory in the contest between it and the railroads of the country over the methods used by the commission in determining the value of railroad properties for the recapture of excess earnings under the provision of the Transportation Act.

Last March the commission issued an order directing the St. Louis & O'Fallon Railway Company to pay over to the government certain excess income under the paragraph of the Transportation Act which requires all railroads to turn over to the government one-half of their income in excess of 6 per cent upon a valuation determined by the commission.

The railroad concerned is a small line, but as the principles involved apply to all the railroads of the country, a test case was made of this order and the railroad company applied to the local district court for an injunction against the order of the Interstate Commerce Commission. Three Federal judges sitting as a special court of the U. S. District Court at St. Louis, have affirmed the commission's decision and refused to grant the injunction. At the present time full details of the report are not available for abstracting. The formal decree will be entered by the full court on Dec. 19 and at that time it is expected that the railroad will appeal the decision so that it may be brought before the U. S. Supreme Court at an early date.

Alabama & Western Seeks to Extend Line

Application has been made to the Interstate Commerce Commission by the Alabama & Western Florida R.R. to extend its line from Chipley to Graceville. The railroad is interested in developing industries in this section, and, within the past week, negotiations are reported to have been closed for the erection of a sawmill at Mussels Mill, Fla., with a reported capacity of 10,000,000 ft. of long and short leaf pine annually.

Huge Overcharge Claimed In $16,000,000 Program of Sewer Construction

Starting out as a conventional sewer assessment protest, a situation has developed in Queens Borough, New York City, involving the borough government in charges of negligence, incompetence, collusion and fraud. The political leaders, centralized in Borough President Maurice E. Connelly, appear to have delegated the engineers of the borough's sewer bureau to bear the brunt of the attack. It is alleged that the assessments, which aggregate about $16,000,000 for trunk sewers only, represent an excess of from $5,000,000 to $8,000,000 above the legitimate cost of construction.

Although there have been charges and denials filling columns of newspaper space, meetings of interested taxpayers, creation of committees, and formulation of plans for submitting specific charges to the Governor, who alone is empowered to institute proceedings looking to the removal of a borough president, the only definite action now under way is a hearing before the Board of Assessors of the City of New York and one before Commissioner of Accounts Higgins, the latter being started at the instance of Mayor Walker. It is here, however, that the borough's engineers have been subjected to close questioning bearing on the competency and faithfulness in executing the borough's sewer program.

Principal Charges Made

The following are the principal charges that so far have been made:

(1) That a patented pre-cast reinforced-concrete pipe has been written into the sewer specifications, thus violating a provision of the city charter which prohibits the use of patented articles except by special permission of the Board of Estimate.

(2) That, on these contracts the specification for monolithic sewers as an alternate to pre-cast pipe, requires a construction so costly as to preclude their use.

(3) That the contract price, which is always that of the lowest bidder, is generally far above engineer's preliminary estimates.

(4) That specification requirements based on contending with large quantities of water where none was encountered during construction have resulted in unnecessary cost to the city.

In addition to these charges of a more or less technical nature is a major charge that use in Queens Borough of patented pre-cast pipe (lock joint) used on the contracts is controlled by a politically favored agent, who has charged contractors extortionate prices for the pipe. Collusion between contractors, between the city and contractors and between the agent and both city and contractors has also been charged.

The Jamaica sewer system was characterized in the fall of 1926, when it had been under construction for some time, as the largest sewer project ever put under construction at one time in New York City. An area of about 11,000 acres was involved, the program including construction of the main trunks, both for a sanitary and a storm system. Much of Queens is underlain with ground water close to the surface, and some parts are subjected to tidal overflow. The screening plant into which the sanitary system empties was described in *Engineering News-Record*, Dec. 23, 1926, p. 1055. It was claimed to be the largest of its kind yet constructed, having a screening capacity on two 26-ft. diameter Riensch-Wurl screens of 80 m.g.d.

Engineering Fifty Years Ago

From *Engineering News*, December 15, 1927

THE *Cincinnati Enquirer* of the 5th inst. contains the form of permanent lease and contract for the completion and operation of the Southern railway. It filled two columns of finely printed matter, and is cut up into numerous digestible pieces by the terms *whereas, sec., art.* and *note*. It is proposed to advertise the plan in Cincinnati and the East and West for bidders, who are expected to take and complete the road under the terms and specifications previously referred to. The length of term and kind of rent is left open for consideration. The lessees are to complete the road, supply the rolling stock, make repairs, pay taxes, to pay money to keep up the organization of the trustees, and to provide trustees with passes and an inspection car, etc., to provide terminal facilities at Cincinnati and Chattanooga, etc. Several legal clauses in regard to perfection, arbitration, power of attorney, successors and assigns, follow *ad infinitum*.

[Renewal of the lease of this unique railway, built and owned by the city of Cincinnati, was noted in our issue of Nov. 17, 1927, p. 816.—*Editor*.]

Plans Under Way to Extend Montreal Postal Terminal

Plans for expanding and modernizing postal terminal facilities in Montreal have been formulated by the Canadian Government at a cost of approximately $2,000,000. Final determination of the scope and detail of the plan will depend upon the settlement of the scheme of the Canadian National Railways for its new passenger terminal on the site of the present tunnel terminal. A general plan for the latter is now before the Dominion Railway Board, and will form the basis of discussion at a hearing to be called probably early in the new year.

Three Engineering Groups Advise House Committee on Flood Control Problem

Three special groups of engineers have been called to Washington to advise with the House committee on flood control, of which Representative Frank R. Reid is chairman. The committee of the American Society of Civil Engineers, appointed by the president of the society at Representative Reid's request, is composed of John F. Stevens, chairman; Dr. Elwood Mead, Washington, D. C.; J. T. Madison, Lakeland, Fla.; J. Waldo Smith, New York City; J. D. Galloway, San Francisco; M. G. Barnes, Chicago; Morris Knowles, Pittsburgh; J. W. Billingsley, New Orleans; and John T. Coleman, New Orleans. This group met with Representative Reid on Dec. 12, though the session was behind closed doors.

In addition to the special committee of the American Society of Civil Engineers, Representative Reid asked the presidents of ten American universities each to appoint that man in his institution he deems best qualified to advise on flood control. The committee thus formed, known as the Universities Advisory Committee, is composed of the following: Dean M. E. Cooley, college of engineering, University of Michigan; Prof. C. M. Spofford, head of the department of civil engineering, M.I.T.; Harry Rubey, professor of civil engineering, University of Missouri; S. M. Woodward, head of the department of mechanics and hydraulics, University of Iowa; B. A. Etcheverry, professor of irrigation engineering, University of California; F. J. Seery, School of Civil Engineering, Cornell; William B. Gregory, professor of experimental engineering and hydraulics, Tulane; Clark E. Mickey, head of engineering department, University of Nebraska; A. N. Talbot, head of the department of theoretical and applied mechanics, University of Illinois; and Francis P. Wilmer, University of Pennsylvania.

Views of railroads will be presented to the House Committee by a special group appointed, on request, by D. J. Brumley, president of the A.R.E.A. This group is as follows: L. A. Downs, president of the Illinois Central; Col. J. R. Fordyce, consulting engineer, Hot springs, Ark.; A. F. Blaess, chief engineer of the Illinois Central; R. W. Barnes, chief engineer of the Southern Pacific Lines; Hadley Baldwin, chief engineer of the Big Four; C. R. Mee, chief engineer of the Louisiana Railway & Navigation Co.; E. A. Hadley, chief engineer of the Missouri Pacific; W. S. Hanley, chief engineer of the St. Louis-Southwestern; C. S. Kirkpatrick, chief engineer of the Gulf Coast lines; F. G. Jonah, assistant to the president and chief engineer, St. Louis-San Francisco; C. A. Morse, chief engineer of the Rock Island; E. F. Mitchell, chief engineer of the Texas & Pacific; E. F. Salisbury, chief engineer of the Louisiana & Arkansas; B. A. Wood, Mobile & Ohio.

Further Contracts for Dredging Hudson at Albany Doubtful

There is strong possibility that the third dredging contract for deepening of the Hudson River at Albany, New York will be held over until spring because of the lateness of the season. The first contract completed by the National Dredging Company called for about three miles of dredging between the Hudson River bridge and Van Wie's point, where the second contract is underway with expectations of being completed by spring. When this second contract is completed, approximately 7 miles of the 27-ft. channel will have been finished. Total operations call for about thirty miles of dredging.

New Census Boundary for N. Y. Metropolitan Area Set

For purposes of the census, a new metropolitan district has been created to supplant the old around New York City. It covers approximately all territory within 40 miles of the New York City Hall, with a population of 9,500,000 and an area of 3,765.5 sq.mi. The boundary was created by a committee representing the Merchants' Association, the Brooklyn Chamber of Commerce, the Queensborough Chamber of Commerce, the Bronx Board of Trade, the Newark Chamber of Commerce, the Regional Plan of New York, the Port of New York Authority, the Transit Commission, the Department of Statistics of Columbia University and the Motor Truck Association of America, all working with the U. S. Census Bureau.

M. N. Baker Honored

(*Continued from p. 976*)

from James H. McGraw, president, who was unable to be present; E. J. Mehren, vice-president and editorial director; Edgar Kobak, vice-president and general sales manager; Fred R. Low, editor of *Power*, and F. E. Schmitt, associate editor of *Engineering News-Record*. At the close of the speeches Mr. Baker was presented with an illuminated appreciation of his long service and a gold watch.

Mr. Baker is the author of *Municipal Engineering and Sanitation*, *Sewage Purification in America*, *Potable Water*, *Sewerage and Sewage Purification* and *British Sewage Works*, all standard engineering works. He is a joint author of *Sewage Disposal in the United States* and of *Municipal Monopolies*. He was vice-president of the New Jersey State Department of Health in 1915-1916 and for many years a member of the Board of Health of Montclair, New Jersey, where he has his home, and was elected its president. He is a member of the American Public Health Association, American Water-Works Association, the New England Water Works Association and other professional societies, and for many years has been a member of the National Municipal League's council.

Washington Notes

THE South Branch Power Company, of Philadelphia, has amended its application to the Federal Power Commission for a preliminary permit covering sites on South branch of the Potomac and on the Cacapon River so as to include all power sites on the Potomac from tide water to Harpers Ferry. This conflicts with the applications of the Potomac River Corporation and with that of Stineman & Quick.

VIGOROUS exception to the activities of the Department of Commerce through the National Committee on Wood Utilization has been taken by representatives of the brick industry. Some of the activities of this committee are interpreted as being a direct effort to supplant brick and other building materials with lumber.

"Interference by the federal government in the competition between two industries sets a bad precedent and is distinctly unfair," Henry E. Stringer, vice-president of the Hydraulic Press Brick Company, stated in commenting on recent statements issued by the National Committee on Wood Utilization. Mr. Stringer points out that the Department of Commerce and other government departments carry on this work for the committee and that officials of the Department of Commerce are the officers of the committee.

Mr. Stringer thinks that it would be highly desirable for the government to make an impartial study of building materials, but he does not think this has been done. He thinks that it is paradoxical for the government to campaign for increased use of wood and yet favor wood conservation. He also states that official publicity states that 80,000,000 people live in dwellings made of wood, but nothing is said about the large cities which have definitely passed the wood age and have turned to fireproof materials for the construction of their buildings.

However, according to Axel Oxholm, of the Department of Commerce, the purpose of increasing wood utilization is to enhance the value of standing timber by producing more wood products from each tree and to make these wood products of greater value to the consumer. Mr. Oxholm states that this is necessary because timber values must increase before capital can be attracted for reforestation. The only other alternative would be to wait until values have increased because of still further depletion of our timber resources, which would be an expensive expedient from the standpoint of conservation.

APPLICATION made by the Ocean City Automobile Bridge Co., Ocean City, N. J., for approval of plans of a bridge to be constructed over the Great Egg Harbor Bay from Somers Point to Bessleys Point, N. J., has been approved by the assistant secretary of war.

Water-Works Men of Pacific Northwest Organize

The Pacific Northwest section of the American Water-Works Association held a meeting in Portland, Ore., Nov. 11, at which time a temporary organization was effected and the following officers elected: President, W. A. Kunigk, Tacoma; vice-president, Ben S. Morrow, Portland; and secretary-treasurer, Kenneth Shibley, Seattle. It is expected official sanction will shortly be forthcoming for the formation of the section, as the requisite number of petitioners required by the A. W. W. A. constitution have forwarded their application to the parent association. Water-works men in the territorial jurisdiction of this section (Oregon and Washington) are invited to affiliate with the section.

Harbor Association Favors St. Lawrence Waterway

The Great Lakes Harbor Association, which held its convention in Toronto, Nov. 16-17, with an attendance of about 250 delegates, adopted a resolution favoring the international development of the St. Lawrence waterways, and denouncing, as visionary, independent plans for either all-Canadian or all-American development stating they were being used by certain parties on both sides of the line, under a cloak of patriotism, to befog the issue. O. E. Fleming, president, Canadian Deep Waterways and Power Association, charged the Montreal interests, who are said to be opposing the waterway, as being actuated by purely selfish motives. W. L. Harding, former Governor of Iowa, presented the American side of the case. Other speakers were C. A. Maguire, vice-president of the association; Herman Ekern, former attorney general of Wisconsin; Daniel Hoan, mayor of Milwaukee; Edgar B. Thomas, chairman of the River and Harbor Improvement Committee of the Cleveland Chamber of Commerce; and Edward I. Cousins, consulting engineer of the Toronto Harbor Commission.

Action on Cableway Up Mount Hood Postponed

Action on the application for permission to construct a cableway to the summit of Mount Hood, Ore., has been postponed for a year by W. M. Jardine, secretary of agriculture. It is stated that during the year a thorough study of the potential public value of Mount Hood, and the way in which this can best be conserved will be made. If investigation shows that the cableway as projected or in modified form is compatible with the best use of Mount Hood, the Department of Agriculture states that it will be approved. At present the Secretary is not prepared to act one way or the other. Col. W. B. Greeley, chief of the Forest Service, had previously rendered a decision adverse to the project.

Personal Notes

PAUL A. SEUROT, chief engineer of the Montreal Tramway Commission, has resigned that position to accept that of rapid-transit engineer for the Montreal Tramway Company.

ARTHUR DU PERRON, civil engineer of Montreal and a professor of engineering at the Montreal Technical School, has been appointed chief engineer of the Montreal Tramways Commission to succeed Paul A. Seurot, resigned.

PAUL H. JAENICHEN, until recently superintendent of construction on building work in Cincinnati, has joined the staff of John R. Freeman, consulting engineer, Providence, R. I. Mr. Jaenichen is a graduate civil engineer of Dresden, Germany. He came to the United States in the spring of 1924. In 1925 he was employed on dam construction work in New Jersey and the next year in design work on theatre and building construction in New York City.

STEVEN B. STORY, director of Bureau of Municipal Research of Rochester, N. Y., has been appointed city manager at a salary of $20,000 a year. The appointment must be confirmed when the councilmen-elect who appointed him go into office on Jan. 2, 1928. Mr. Story has been director of the Bureau of Municipal Research since June 9, 1921. He was on the staff of the Bureau two years prior to that. Mr. Story was born in Brooklyn Jan. 26, 1890, and was graduated from the public school in Freeport, L. I., in 1904. He entered Union College in 1910, being graduated there in 1914 with a degree of Bachelor of Engineering. He then entered the training school for public service in New York City and later joined the staff of the New York Bureau of Municipal Research. After a term of service during the World War he went to the Rochester Bureau of Municipal Research. In 1917 he received the degree of Master of Civil Engineering at Union College.

THE CORNET-CASEY CO., INC., has been reorganized as the Cornet Co., with the following officers: Frank C. Cornet, president; Henry L. Cornet, Jr., vice-president, and Hender C. Schuyler, secretary and treasurer. The company will continue its present offices in St. Louis.

H. V. CAMPBELL, engineer-inspector for the Panama Government on the Chiriqui Railroad, and formerly assistant chief engineer, Manila Railroad Company, is returning to Manila as superintendent of construction on the extension of the southern lines of the Manila Railroad.

D. W. FRENCH, manager of the Hackensack Water Company, and who began service with that company Sept. 1, 1883, has resigned this position and has been appointed consulting engineer of the company. Mr. French is a graduate of the Massachusetts Institute of Technology. Following his college course, he was employed by the Worthington Hydraulic Works then located in South Brooklyn, N. Y. After being with the Worthington company for a few months, he was sent on field work and later was given charge of the erection of the original plant of the Hackensack Water Company at New Milford, N. J., in the spring of 1882. The next year he installed the high-service station of the Hackensack company at Weehawken, N. J., and upon the completion of this work was invited by officers of the company to remain with them as engineer in charge of the high-service station and district. This offer he accepted that year. In 1887 he was appointed deputy superintendent which carried with it authority over all of the plants of the company in territories then supplied. Upon the death of Charles B. Brush, chief engineer and superintendent, Mr. French was appointed superintendent, which post he held until less than two years ago when his title was changed to manager.

Engineering Societies

Calendar

Annual Meetings

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES, Washington, D. C.; Annual meeting, Miami, Fla., Feb. 6-9, 1928.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Monday, Feb. 14-16, 1928.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

THE BUFFALO, N. Y., SECTION of the American Society of Civil Engineers at its Nov. 18 meeting had an address on the waterfront improvements at Toronto, Ont., by Edward L. Cousins, consulting engineer, Toronto.

THE NEW ENGLAND SECTION of the Society for the Promotion of Engineering Education was a guest on Nov. 18 of Tufts College. The events were inspection of the college, an address by Henry E. Wickenden on recommendations for changes in the studies in engineering schools, the annual banquet of the society, and reports, with discussion, of the summer school for engineering teachers at Cornell University.

THE TEXAS SECTION OF THE SOUTHWEST WATER WORKS ASSOCIATION will hold its tenth annual short school and convention in Houston, Texas, Jan. 23-27, 1928.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting June 25-29, 1928, at Atlantic City. The decision to hold the meeting there was made at a recent meeting of the executive committee of the society.

THE NEW YORK SECTION of the American Water Works Association will hold a luncheon meeting at the Hotel Pennsylvania Dec. 28. The following portions of the American Water Works Manual will be discussed: Collection and quality of water, including chapters 1, 2, 3, 4 and 5; treatment of water, including chapters 6 to 12; and pumping, chapter 15. The first discussion will be opened by Allen Hazen, the second by Dr. Frank E. Hale, Department of Water Supply, New York City; and the third by F. G. Cunningham, of Fuller & McClintock, New York City.

Obituary

SAMUEL J. FIELDS, at one time city engineer of Buffalo and also for some time resident engineer with the New York Central Railroad, died recently in Buffalo at the age of 83 years. Mr. Fields was one of the older members of the American Society of Civil Engineers, having been elected to membership in 1884. During his professional career Mr. Fields was resident engineer of the New York Central Railroad, later being in charge of the bridge building department. He was chief engineer at a still later date of the Niagara Bridge Works. In 1893, 1894, and 1895 Mr. Fields was city engineer of Buffalo and was chief engineer for the Pan-American Exposition held in Buffalo in 1901 and engineer for the St. Louis exposition in 1903.

FRANCIS W. MCKINNEY, who until recently was harbor engineer of Baltimore, died suddenly on Nov. 25, of heart disease. Born in New York, Mr. McKinney spent several years in mining and railroad work in the United States and Mexico. He became connected with the Sewerage Commission of Baltimore and in 1913 was made chief engineer to the commission for opening streets. He spent more than four years in that position and then did work at the government proving ground in Harford County, Md. After the war he was made assistant harbor engineer and when Bancroft Hill resigned as harbor engineer Mr. McKinney was named to fill the vacancy. He was one of the municipal officials replaced when the city administration changed recently. Mr. McKinney was 46 years of age.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Lower Freight Rates on Pipe to Southwest Asked

A petition for a hearing in behalf of lower freight rates on cast-iron, wrought-iron and steel pipe has been filed with the Interstate Commerce by the Southwestern Pipe Consumers' Committee, represented by C. H. Campbell, of the Lone Star Gas Co., Dallas, Texas. The Dallas Gas Co., the City Water Department of Dallas and over 100 other municipalities, private utilities and firms in the Southwest are represented on the committee mentioned. The petitioners ask to have the proposed new freight rates set aside on the classes of pipe already named. They claim that if the rates go into effect (Feb. 3, 1928) the increases will run to 7.4 per cent in some cases. Colonel Moss, of the Dallas Water Department, is reported as having said that the $2 a ton increase ($12 to $14) on cast-iron pipe shipped to Dallas, the city would have to pay $72,000 on the pipe it expects to use for this year's program.

Association President Points Out New Markets for Cement

At the recent annual meeting of the Portland Cement Association in Chicago, G. S. Brown, president of the association, reviewed the present status of the portland cement industry and considered some of the potential markets for present excess production capacity. Although the year 1927 has recorded the largest consumption of cement in history about one-quarter of the total capacity of the mills has been idle, for along with a reported consumption for 1927 of 170,000,000 barrels, latest government figures show an annual plant capacity of about 230,000,000 barrels.

In connection with a number of suggested outlets for more cement, President Brown mentioned several dangers to be guarded against. "We must be careful," he said, "lest in our effort to furnish a product, which will meet the special requirements of various individuals throughout the country, we do not so increase our cost as to cut down its use. It is not impossible to damage, perhaps irretrievably, a great industry by increasing cost to the point where substitutes will take the market. I hope to see the quality of cement improved, but not to the extent that the public is deprived of so cheap and useful a building material." Speaking of foreign cement, he stated, "The margin between cost and net realized has continually narrowed down during the year in most sections of the country due in part to importation of foreign cement which, while of less volume than in 1926, is still a very real menace on all of our seaboards."

Where can the surplus production capacity be placed? Mr. Brown listed a number of possibilities: Road building is behind demand in many places and cement use can be increased in this field; separating heavy traffic from light in the large cities will result in double-decked streets which should provide a further outlet for surplus production; grade crossing elimination, toll bridges and toll highways were offered as potential structures for cement construction; the suggestion was also made that building the first floor of all structures of concrete would reduce the fire waste throughout the country.

Company Creates a Sound Insulation Division

The U. S. Gypsum Co., Chicago, announces a new professional service in providing for the planning and installation of equipment to prevent the transmission of sound. On the basis of plans for the structure, recommendations are made as to the character and amount of sound insulation needed. Installations are handled entirely by the company, preferably under separate contract. There has been created in the company a Sound Insulation Division which is prepared to furnish analyses, recommendations, and cost estimates in connection with any sound insulation problem.

Business Notes

ROME MFG. CO., Rome, N. Y., announces the establishment of a branch office in Richmond, Va. W. S. White, who will act as manager, was for 22 years local manager for the Austin-Western Road Machinery Co. Associated with Mr. White will be P. G. Purdue, W. M. Masters and C. L. Hechler.

LEIPZIG TRADE FAIR, INC., New York City, announces that Herbert A. Johnson has been appointed New York manager to succeed the late E. A. Boettcher. The next Fair dates are March 4-14, 1928.

WHITING CORP., Harvey, Ill., announces the election of A. H. McDougall as vice-president and director of sales. Mr. McDougall has been with the Whiting Corp. since 1903, successively as designer, estimator, chief draftsman, chief engineer, and vice-president and consulting engineer.

GENERAL EQUIPMENT MACHINERY CO., Miami, Fla., has taken over completely the machinery department of the I. E. Schilling Co. The officers of the new company are I. E. Schilling, president, and continuing president of the I. E. Schilling Co.; Chris Dorn, vice-president and manager, formerly sales manager, Acme Road Machinery Co. and field sales manager, Ryan Mfg. Corporation, Chicago; J. B. Ober, secretary; and L. W. Coffeen, treasurer.

MASTER BUILDERS CO., INC., has recently opened a manufacturing plant in Buffalo, N. Y. This is the third manufacturing plant operated by the company.

LEADITE CO., Philadelphia, Pa., has recently secured the services of Louis P. Allen. Mr. Allen was for several years superintendent of construction for the Consolidated Water Co., Utica, N. Y.

BLAW-KNOX CO., Pittsburgh, announces the appointment in its "security" grating department of the following distributors: Worden-Allen Co., Milwaukee, Wis.; Wilson-Weesner-Wilkinson Co., Knoxville, Tenn.; and James A. Ball, Houston, Texas.

New Developments

New Portable Saw Rig Designed To Give Improved Service

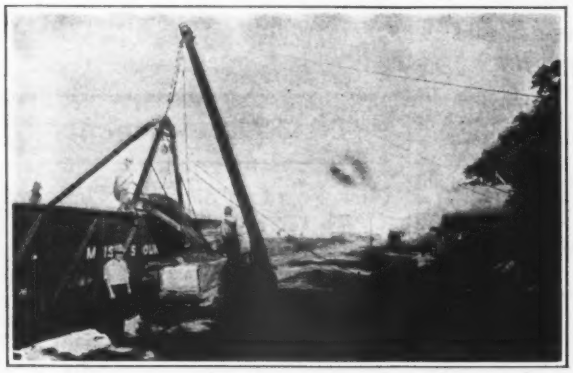
The new features of the portable saw rig recently placed on the market by C. I. Longenecker, Milwaukee, Wis., are said to include easier handling, greater output, more widely varied uses and safer operation. Especially contributing to a greater variety of uses for the machine is the new tilting table top. The cutting capacity is said to be greatly increased because the saw travels in a straight line, thus providing the same cutting depth for the entire length of the stroke.

Safety means a great deal around

wood cutting machinery. The cut-under frame permits a person to stand in a natural position when operating the saw which is continually and automatically guarded, either when ripping or cross cutting. The new saw is powered with an 8-hp. two-cylinder LeRoi gasoline engine mounted beneath the table where it is fully protected. This construction also makes a close compact design requiring minimum floor space.

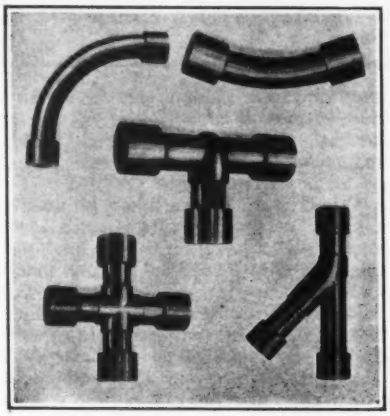
Rapid Unloading of Gravel Cars By Small Tractor Hoist

By using ordinary slip scrapers operated, through sheave blocks, by a hoist attached to a Fordson tractor, G. H. Vickerman, contractor in Caledonia, Minn., has perfected a rapid unloading scheme for gravel cars. A tripod carrying the two sheave blocks is attached to the sides of the car with vise-type screws. The hoist consists of a double drum Porta-Hoist manufactured by Pioneer Tractors, Inc., Winona, Minn. It is equipped with special drum lagging to make the speeds of both drums equal, and with special driving sprockets to reduce the cable speed to approximately 90 ft. per minute on both drums. The cables from the drums run through the sheave blocks and are attached to a pair of scrapers. Each scraper is operated by one man, dumping onto a chute as shown in the accompanying illustration. This installation is said to unload 60-ton cars at the average rate of a little better than one per hour, the best time being 38 minutes for unloading a car containing 38 cu.yd.



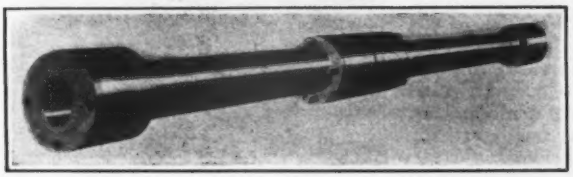
Specially Resistant Pipe of Wood Fiber in 2 to 6 In. Sizes

A new pipe claimed to be immune to corrosion and rust, has been placed on the market by the Brown Co., Portland, Maine. Bermico mine pipe, as it is called, is made of wood fiber, rolled up layer on layer. Collar ends of larger diameter are pressed on and pegged, making them integral with the pipe itself. These ends are drilled lengthwise, with 4, 6 or 8 holes through



which pass threaded rods of cold rolled metal to connect the pipe lengths. The pipe itself is impregnated with pitch by a cooking process. The insides and ends are finished with a hot iron process giving what is claimed to be an almost glass-smooth effect. The cooking results in a tough, smooth surface not only waterproof but acid-proof as well. The connector bolts are capped with nuts of acid-resisting metal. A gasket of rubber, fiber or other suitable material is used to complete the seal and the joint.

Over and above its advantages in immunity to corrosion and rust, Bermico pipe is said to be very light and easy to handle. It can be laid without skill or special tools. The pipe is available in diameters of 2 in. to 6 in. in convenient lengths as well as in curves, branches, tees, etc. By means of a special connector, Bermico pipe can be connected up with standard pipe flanges.

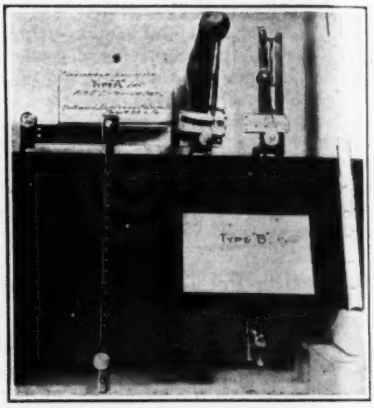


New Lever-Type Extensometer Has Wide Application

The extensometer manufactured by A. Huggenberger, Zurich, Switzerland, is being introduced in the United States by the Southwark Foundry & Machine Co., Phila., Pa. The operation of the extensometer is based on the lever principle and thus a scale is used instead of a dial indicator. It is claimed that no specimen, structure, or material object is too large, too small, or too oddly shaped that the Huggenberger "Tensometer" cannot be set upon it with the aid of fixing devices available with the instrument. Three types of tensometers are manufactured, type A being essentially a laboratory instrument, and types B and C for field use. In each of the types, shown in the accompanying illustration, the tilting knife edge is the lower extremity of the lever directly above it. It is from this point that movement in the specimen is transmitted through the open lever system to the pointer.

In the type A instrument the scale is 1.9 in. long graduated in divisions of 0.05 in. The instrument has a lever multiplication of about 1,200 to 1, and changes in length of the specimen down to 0.00001 inch can be read. In the illustration, an extension bar is used with type A, and these are available altering the gauge length of the instrument to 4, 8, 20, 30 or 40 inches, as desired. The instrument weighs 2½ oz., stands 6½ in. high and is 2 in. wide.

The scale on the type B, and similarly on the type C, is 1.7 in. long,



graduated in divisions of 0.05 inches. This type has a lever multiplication of about 1,000 to 1 (in type C is 300 to 1), and is especially suitable to field measurements in exposed structures where dust, rain and snow are encountered. Changes in length of the specimen of 0.00001 inch may be measured. Type B has a standard gauge length of 1 in., weighs 2¼ oz., stands 5¼ in. high and is 1⅞ in. wide.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Home Building On Increase In New York City

Lumber manufacturers see prospects of a steadily increasing volume of demand for their product, in the results of a recent survey of the real estate situation in New York City. It is evident from the report, that a de-centralization process is in operation, as far as residential buildings are concerned. According to the lumbermen, more and more prospective home owners are turning from the congested areas and facing in the direction of the outlying districts. Obviously, the one and two-family houses would exceed multiple-family dwellings in the number erected during a given period. The exceptionally heavy gain of the former over the latter in the eight years (1918 to 1926) shows, however, that construction of small houses in New York City is far surpassing the building of apartments, regardless of the trend toward the suburbs.

The Southern Pine Association is quoted, in this connection, as follows:

"This survey of construction activity showed that in the eight years between 1918 and 1926 the number of one and two-family houses erected in New York totaled 122,332, an increase of 45 per cent over housing accommodations of this character at the beginning of the period. Multiple dwellings, consisting of tenements, hotels and apartments, show an increase for this same period of only 6,193, or 5 per cent."

Rents Compared with 1913 Levels

The following comparison of rent increases in residential, office, and factory buildings, compared with 1913 levels, is supplementary to the table covering similar data in twenty cities, as shown in *Engineering News-Record*, issue of Nov. 10, 1927, p. 779. Properties were selected in these compilations, on which the land values had not greatly increased since 1913. The gains shown, therefore, are largely attributable to higher building costs.

PER CENT RISE IN RENTS SINCE 1913
Engineering News-Record Statistics

	Residential	Office	Factory
Atlanta, Ga.	50	66	80
Cincinnati, O.	84	82	81
San Francisco, Cal.	150	30	..
Toronto, Ont.	70@95	100	35
Knoxville, Tenn.	92	100	50

On a painting job estimated to cost $3,400, in connection with the Alliance, Ohio, sewerage works, the average of thirteen bids was $1,725 or 51 per cent for materials, $1,673 or 49 per cent for labor, with wide ranges in the bidding.

Gain in Money Spent for Public Improvements

State and municipal bond flotations for the first ten months of 1927 total $1,245,537,882, which is the highest total for this period in any year since the World War, with the exception of 1924. Public bond issues during the first ten months of that year reached the peak, totalling $1,252,844,752. The figure for the ten months ending October 31, 1927, represents an increase of $102,472,716 over the flotations for the corresponding period of 1926.

The following table compiled by *The Daily Bond Buyer* of New York, shows the volume of State and municipal bond flotations in October and during the first ten months of each year for the past ten years:

	October	10 Months Ending Oct. 31
1927	$110,851,682	$1,245,537,882
1926	105,076,241	1,143,065,175
1925	84,774,505	1,166,906,834
1924	96,075,710	1,252,844,752
1923	101,548,462	905,652,096
1922	75,124,658	1,132,455,766
1921	125,126,375	948,135,416
1920	62,592,014	627,494,610
1919	117,284,139	634,775,848
1918	10,292,635	217,275,175

Building Materials Imports Decline

American manufacturers of construction materials other than steel, may view with satisfaction, the following extract from latest reports issued by the Chamber of Commerce of the United States, on volume of foreign trade.

Imports during the first half of the current year, compared with the corresponding period in 1926, show substantial reductions in the following: portland cement, pig iron, steel bars, steel ingots, plate glass, boards, planks, wood lath, telephone and telegraph poles and shingles.

Increases occurred in only three classes, namely, pipes, tubes and fittings; iron and steel structural shapes and building forms; logs and timbers.

Quantity comparisons in imports of construction material, for the first six months of this year and last, are as follows:

Material	1927	1926	Per Cent Gain (+) or Loss (—)
Boads, planks, deals, etc.	861,000 M.ft.b.m.	882,000 M.ft.b.m.	— 2.3
Poles—telephone and telegraph	271,000	317,000	—14.7
Lath	728,000,000	867,000,000	—16.0
Shingles	895,000,000	1,112,000,000	—19.5
Steel bars, ingots, etc	128,509,000 lb.	164,193,000 lb.	—21.7
Plate glass	9,430,000 sq.ft.	13,974,000 sq.ft.	—32.5
Cement	366,791,000 lb.	739,243,000 lb.	—50.4
Pig iron	135,115,000 lb.	710,183,000 lb.	—81.0
Iron and steel structural shapes and building forms	168,755,000 lb.	107,121,000 lb.	+57.5
Logs and timbers	130,000 M.ft.b.m.	81,000 M.ft.b.m.	+61.4
Iron and steel tubular products (pipes, tubes, and fittings)	179,178,000 lb.	90,328,000 lb.	+98.4

Industrial Building Close to 1926 Mark

Figures in the accompanying table represent number and value of contracts awarded in the United States, for industrial buildings, valued at $40,000 and over, during the period Jan. 1 to Dec. 1, this year and last.

It will be noted that the following industries show gains in both number and value of lettings, comparing the eleven months this year, with last: food products, automotive, steel, refrigeration and cold storage, warehouses, and unclassified factories. Declines in both number and value occurred in the following: machine shops, machinery and equipment, printing and binding, cement and quarry products, foundries, lumber and woodworking mills.

Number and Value of Industrial Building Contracts in First Eleven Months

Millions of Dollars (000 omitted in value)

	1927	1926
Public Utilities		
Value	$40,921	$86,982
Number of contracts	103	86
Chemical Process		
Value	17,484	19,172
Number of contracts	93	93
Food Products		
Value	21,634	19,713
Number of contracts	153	146
Automotive		
Value	29,868	27,755
Number of contracts	196	190
Machinery and equipment		
Value	22,804	58,956
Number of contracts	153	323
Textiles and clothing		
Value	51,357	12,005
Number of contracts	84	108
Printing and binding		
Value	3,881	7,287
Number of contracts	35	45
Steel mills		
Value	11,652	6,180
Number of contracts	25	15
Cement and quarry products		
Value	6,802	18,572
Number of contracts	18	28
Foundries		
Value	1,633	3,442
Number of contracts	12	43
Refrigeration and cold storage		
Value	6,328	5,242
Number of contracts	48	39
Lumber and woodworking		
Value	2,353	6,864
Number of contracts	21	45
Warehouses		
Value	10,499	10,221
Number of contracts	65	43
Unclassified		
Value	40,671	17,110
Number of contracts	274	158
TOTAL		
Value	$267,878	$299,501
Number of contracts	1,280	1,362

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
December 15, 1927.	$13,515,000	$46,115,000	$59,630,000
December 8, 1927.	19,353,000	55,596,000	74,949,000
December 16, 1926.	16,559,000	36,596,000	53,155,000
Jan. 1 to date			
1927	1,213,356,000	1,894,585,000	3,107,941,000
1926	1,057,743,000	1,734,067,000	2,791,810,000

E.N.-R. Index Numbers

On December 1, 1927

COST	VOLUME
203.90	272
Last Year 210.80	Last Year 211

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb.	$3.34	$3.75	$4.00	$3.10	$3.35	$3.95	$3.00	$3.00	$4.00
Structural rivets, per 100 lb.	5.00	4.00	4.75	3.60	3.85	4.64	5.75	5.25	5.50
Reinforcing bars, per 100 lb.	3.24	2.99	2.75	2.50	2.87½	+3.87½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	38.60	34.50	52.00	34.60	—40.00	52.00	48.50	53.00	41.00
Concreting Material									
Cement, without bags, per bbl.	2.25@2.35†	2.45	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.	1.75	.....	2.38	2.00	1.25*	1.90	1.80	1.25	1.50*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.25	—1.25*
Crushed stone, ¾ in., per cu.yd.	1.85	.....	2.83	2.00	1.25*	2.50	1.70	2.50	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.50(848)	36.75 @38.75	33.75	27.00	24.00	50@55
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	60@62†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton	22.50@24.50†	21.50	19.00	20.00†	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	3.25@3.50†‡	1.25	1.82	1.50†	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@17.00†	11.50	—13.50	12.00†	13.75†	8@12	13.00	14.00	20.25
Hollow building tile, 4x12x12, per block	.....	.068	—.094	.....	.072	.085	.....	.10	.10
Hollow partition tile, 4x12x12, per block	.0966	.068	—.094	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.79½	.84	.85	—.80	.87½	—.85	84	.98	—.90
Common Labor									
Common labor, union, per hour	.90½	.30	.....	.90	.....	.....	.50@.60	.70	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.31½@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

PRELIMINARY estimates on total value of all contracts let in the United States for the year 1927, show the construction industry to be holding the seven-billion-dollar line, as in 1926 and the year preceding. It is likely, however, that buildings (residential included) will show a decline slightly over 3 per cent, when compared with 1926 totals in this class. Construction other than buildings, will undoubtedly realize an increase of not less than 8 per cent, compared with last year's contract figures.

A protracted gain in contract letting in several or in all classes, does not result, necessarily, in price advances. If building materials production outruns shipments, there is consequent increase in reserve stocks and proportionate weakening of prices. This is the case, at the present time, in brick, softwood lumber, and linseed oil. The opposite condition, however, obtains in cement, hardwood lumber, and steel.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The expected firmness has not yet appeared in brick prices. Quotations are lower at Dallas this week, following recent declines in Eastern and Western cities.

Softwood lumber sold, cut and shipped, in the first forty-eight weeks of 1927, amounted to 10,000,000,000 ft. as against 11,000,000,000 ft. for the corresponding period last year, according to the National Lumber Manufacturers' Association. Possibilities of price weakness are seen, however, in the present increase in stocks, which results from a rate of production in excess of that of shipments.

An unusual yield of flax on a slightly reduced acreage, gives a 1927 production for the U. S., of approximately 24,300,000 bu., the second largest output in fifteen years. Prices of linseed oil tend downward throughout the entire country.

Cement mill shipments are sufficiently far ahead of production to leave reserve stocks at seasonal levels and prices consequently in little danger of abrupt advances.

Hardwood shipments (forty-eight weeks) are in excess of production, with stocks receding and prices showing firmer tendencies.

The existing ratio between steel output and demand is such, that prices will show a tendency to rise, particularly in the principal hot-rolled products.